FORESTS AND FORESTRY IN GREAT BRITAIN

FRONTISPIECE: *There is Land for New Forests in the Uplands of the North and West.*

FORESTS AND FORESTRY IN GREAT BRITAIN

By

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PREFACE

THIS book has been written in the hope that it will serve to meet the need for a short outline of forest history and forestry in Great Britain, and the bearing our national forestry policy will have on the future welfare of the British people.

For a long period forestry has played no more than a minor part in our national economy. In spite of this we remain foresters at heart, and deep down in our consciousness, the forest sense possessed in more practical form by the peoples of the forest-owning nations of Europe and elsewhere lies quiescent, never having been quite extinguished in spite of the fact that our ancient forests all but vanished so long ago. The word 'forestry' conjures up pictures of green woodland as an inevitable feature of the British landscape, but intimate knowledge of all that our woods and forests mean to us, and of the business and aims of forestry, which, from hard necessity, has at last been taken with some seriousness in this country, is not so widely spread.

This brief story of British forests and forestry endeavours to steer a course between the Scylla of generalization and the Charybdis of technicality, and although it has not been possible to avoid some technical detail, the book makes no pretension whatever as a text-book. If the following chapters help to spread interest in our woodlands, and in the trees and other things that grow and dwell there, and knowledge of the means by which forests are raised and conserved for the use and enjoyment of man, and, above all, to give an idea of the true value of forestry to us in this island realm, the effort will have been amply rewarded.

The accumulated volume of forestry literature in many languages is now very large and I have drawn from the works of a number of authors. However, writing as I have at odd moments and in war-time conditions, and without access to many of my books and notes, it has not been possible to quote individual references, except in a few cases. My acknowledgements and thanks are due to all workers in the cause of forestry whose writings I have read and profited by at one time and another.

I am also indebted to Mr. W. H. Guillebaud, B.A., Chief Research Officer, Forestry Commission, for his kindness in reading my manuscript and for giving me the benefit of his criticism and advice, and to my wife for her encouragement and for her patient help in the preparation of proofs for the press and the compilation of an index.

I have received much kind help in my search for photographs from which to reproduce the illustrations to this book. Acknowledgements are made in the List of Illustrations herein to all who have made their negatives or prints available for the purpose, to each of whom I tender my grateful thanks.

W. L. T.

BRISTOL, 1942–3
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CONTENTS

LIST OF ILLUSTRATIONS

A.D. 1664

'After due reproofs of the late impolitic waste and universal sloth amongst us, we should now turn our indignation into prayers, and address ourselves to our better natured countryman, that such woods as do yet remain entire might be carefully preserved, and such as are destroyed sedulously repaired. Truly the waste and destruction of our woods has been so universal that I can conceive nothing less than universal plantation of all sorts of trees will supply and encounter the defect; and therefore I shall here adventure to speak something in general of them all; though I chiefly insist upon the propagation of such only as seem to be most wanting and serviceable to the end proposed.'

JOHN EVELYN

THE STORY UNFOLDS

And here were forests ancient as the hills,
Enfolding sunny spots of greenery. COLERIDGE

FROM the beginnings of human development man has turned to the wood, bark, leaves, fruits, and juices, of forest trees for material to satisfy his needs, and on which to employ his arts. Products of the forest, of which wood stands pre-eminently foremost, have had a potent influence on the course of civilization and, to-day, the timbers of conifer and broad-leaved trees, the softwoods and hardwoods of commerce, play an enormously important, in fact an irreplaceable, part in everyday life. The timbers demanded by modern industry come almost entirely from the great forest belt of the Northern Hemisphere in parts of which industrialism has also developed most intensively, and, over all the world, where great populations have arisen, the history of forests and forestry has run a closely parallel course, commencing with a period of destruction, waste, or over-eager exploitation, followed as time went on by intermittent misgivings in regard to supply and, where the folly of denudation has been perceived in time, by tardy attempts to protect and conserve. The processes of forest denudation, moving inexorably like a slow-motion picture, are as strikingly exemplified in Great Britain as anywhere else. On the opposite side of the Atlantic Ocean, where early settlers in North America found a wealth of primeval forest to all appearances inexhaustible, the tempo of destruction has been vastly more rapid. In Canada and the United States, the havoc caused by reckless exploitation and fire has, in a little over a century, brought about results which bear a close resemblance to those portrayed in the long drawn out and more deliberate train of circumstances to which older countries, including Britain, owe the disappearance of their once extensive natural forests of conifer and deciduous hardwood trees. Russia is an exception but, for climatic and other reasons, great tracts of Russia and Siberia have never yet become densely populated or intensively exploited.

The present era of forest history in Great Britain reaches far back to a time fixed by scientists at some ten thousand years ago. The Great Ice Age was then drawing to its close and the last of the ice sheets which, at one time and another, have overlaid most of

the country were melting and retreating, leaving behind a desolate land of bare, rocky hill-sides, rock-strewn valleys, moraines, and tundra-like plain. Very slowly, under the mellowing influence of milder climates, fertility was reborn in the frozen soils and vegetation re-established itself once again. At this time what is now the island of Great Britain formed an integral part of the European mainland, and plants of the familiar wild species known to-day were able to advance over the then existing land connexions, and root themselves progressively in the newly warmed earth, spreading their spores and seeds, as they still do, by wind and flood, through the agency of birds, and on the fur and feet of animals.

Survivals of an Ice Age flora, probably including species of dwarf birch and willow, no doubt also spread from the summits of mountains which had surmounted the glaciers and remained unscoured. It cannot be doubted that many pioneer plant colonies perished and that some of the immigrant species failed to gain a permanent footing, but the prodigalities and persistencies of nature are proverbial and, by degrees, the stark, ice-devastated wastes were reclothed with verdure. The flow of species from the European Continent continued until cut short by cataclysms which caused the severance of all land bridges, and flooded the low-lying lands which formerly extended between the coasts of East Anglia and Lincolnshire and the Low Countries. These severances put a final limit to the natural influx of species into Britain and account, principally, for the fact that our native British flora lacks many plants and some trees common to the mainland of Europe. These species either failed to secure permanent lodgement or their movements were too slow to enable them to gain access before the break-away became complete. From this period our wild flora has only been enriched from seeds casually washed up on our shores by the waves, or carried by migrating birds, and by means of artificial introductions made by man in his subsequent ventures across the intervening seas.

There is evidence that birch was the first forest tree to establish itself, and that some of the willows were among the earliest of the woody plants to arrive. Pine, hazel, alder, oak, lime, poplar, and wych elm followed on, with others of the trees and shrubs now claimed as native of Britain. The distribution of the ash remains obscure, and beech appears to have been among the latest of the tree species to gain, or regain, a foothold; as to English elm, no one really knows just where it came from or how it arrived; there

is considerable speculation on this point. Knowledge of early tree immigrations, and of the coming of other plants, is derived from material obtained from contemporaneous formations, especially the more ancient of the peat bogs. The presence of tree stumps, cones, and other parts of trees embedded in peat has been known for centuries, but methods of pollen analysis, developed by Erdtman and others by systematic study of the pollen grains embalmed and preserved in successive layers of old peat beds, have recently opened up wider and more sharply focused fields of view. These grains of ancient pollens, when recovered and identified under the microscope, give positive evidence of the chronological and local distributions of their parent trees and, so, the species are not only established as truly indigenous but their travels can be traced with accuracy, closely in the order in which they actually occurred. Indications of former tree growth are also found in the buried forests which lie covered by the tides around our coast-line, and in the moor-log fished up from time to time in the trawls and dredges of the North Sea fishermen. Thus, a fairly complete general picture has been pieced together of the sequence in which native British timber trees established themselves, and of the order in which different types of forest succeeded one another throughout the country. The changes, of course, occupied many thousands of years, and ages were yet to pass before men began to record history. In the meantime, vegetation, including trees, spread far and wide, and the great tracts of forest which grew up clothed the country extensively and more or less densely with woods, sometimes in the form of high forest, sometimes as open woodland, and elsewhere as mere scrub.

Forest, as a present-day term, includes all types of woodland and, in common with most other things in nature, forests are subject to continuous metamorphosis over aeons of time. Nature never really remains at rest and the structure of primeval forest, even when untouched by human interference, is not excepted from the universal tendency of plant communities or, it may be, single species, to supplant one another in endless succession, to culminate, in the case of forests, in the dominance of the tree or trees best adapted to the prevailing environment, a condition of *climax* which was attained in the ancient pine forests of Britain and again, later on, in the oak and mixed deciduous forests which came after. But climax forest is no more eternal than anything else in mundane affairs. Slow changes, hastened or retarded by variations of climate

and other vital circumstances which bring about the rise to climax conditions also, in course of time, operate in the reverse direction; retrogressions set in, and sooner or later the whole process of rebuilding to the point of climax starts all over again. This see-saw of natural succession determined the geographical distribution of species from one millennium to another in the forests of pre-history.

With what has been called the 'balance of nature' operating unhindered, primeval forest cannot have known many devastating foes apart from lightning, storm, and flood, although as the frozen land that is now Britain burgeoned again and animals of the European fauna also made their way into the country in search of food and shelter, harm influencing natural succession would be done among the trees by browsing animals and rodents. However, if such wild denizens of the forest were then more numerous, so were the carnivores—bear, wolf, lynx, and others—to keep the herbivorous browsers and rodents in check. Rabbits had not yet appeared upon the scene, and how far insects and fungi were then active in forest destruction it is hard to estimate. The human animal had yet to develop his onslaught. Plants and wild animals were the precursors of primitive man, the food-gatherer and hunter, and to forested land the first coming of man has always proved portentous. Men of the Stone, Bronze, and Iron Ages followed one another in the peopling of Britain and, with tools increasing in efficiency and the command of fire, war was joined against the primordial forests in grim earnest, to be waged without cease, as in all other parts of the inhabited world, except where reason, urged by the direct threat of deprivation of the many necessary things forests bestow, has eventually called a halt.

The dire effects of man's unrestrained impact on the forest have resulted in denudations either utterly sweeping, as in parts of Europe, Asia, and Africa as well as of the New World, or almost complete, as at home. Many parts of the world suffer from these extravagant clearances, the results of which are to be seen in the loss of fertile soils by erosion, loss of control over the natural flow of water, and diminished opportunities for employment and the accumulation of wealth, as well as in actual scarcities of timber. An increasing number of nations are obliged to buy their wood from other more fortunate, or more forest-thrifty countries, and import it. The extent of modern forest devastation is also reflected in the glare of the ghastly forest fires that occur year after year, and in the widening search for blocks of timber for commercial purposes which

leads exploiters farther and farther away from centres of consumption and profitable markets.

For a thousand years Britain has been blind to the progressive diminution of her forest resources and, latterly, in the superficial judgement of a phenomenally prosperous nineteenth century, in which the timber-consuming population of this island grew from 10½ millions to 37 millions, the importance of British forests and a home-grown timber supply weighed lightly against facile importation and foreign trade. Timber has been of little concern, except as a pawn in foreign trade and, to the people in general, the very wealth of hedgerow and park trees, and of woods and spinnies about the country-side, has contributed to obscure the true position. Forests survive only where man's destroying hand is checked in time, and only among peoples who are imbued with a national sense of the importance of forestry.

Ever since the 'ancient Briton' began to forsake the life of a wandering food-seeker and to settle in communities, the natural dread of primitive peoples for densely wooded forest has grown less, and from this period it is safe to say that the verges of the woods were constantly bitten into. Nevertheless the records of Roman writers tell us that, at the beginning of the Christian era, they found Britain a land of forests. There were great forests in the Weald extending from Kent into Hampshire and Dorset; in the country lying between the Cotswolds and the River Wye; along the Welsh Marches and into the valleys of Wales; over the plains of the Midlands and Eastern Counties, and on both sides of the Pennine Chain stretching northwards far into Scotland and the Highland glens. Tales of widespread cutting and burning by Roman cohorts in the course of their military and road-making activities, and by other invaders, may have been exaggerated, but some responsibility for forest destruction is doubtless to be laid at their door. Later, when conditions under Roman rule became relatively peaceful, increased cultivation, grazing, and the need for fuel, imposed further contributions from the woods, but the marked scarcity of Roman remains in certain parts of England justifies a belief that no extensive permanent penetrations were made into many of the larger tracts of forest.

The invading Saxons, in the fifth century A.D., brought the beginnings of far-reaching changes to the country-side which boded ill for the forests of Britain. Unlike that of their predecessors, who had occupied the higher-lying lands and ridges, Saxon agriculture

was attracted to the fertile valley lands, where the new settlers made, or enlarged, many clearings on these richer soils. They drove the Romano-Celtic population from their upland cultivations, many areas of which fell into disuse and reverted to forest or scrub. It may be conjectured that the value of woods in the neighbourhood of villages began to be realized before this, but, as Saxon power developed, the increase of their flocks, herds, and tillages necessitated persistent inroads into surrounding woodlands. The mast-bearing oak and beech were prized for their pannage, and other trees, pollards, and coppice for the shelter and browsing of stock: on the other hand, more timber was wanted for fuel, house building, and industry.

Conflicting interests inevitably led to the first early essays in forest protection and King Ine of Wessex (A.D. 690), who quaintly adjudged fire to be a *robber* and the axe an *informer*, enacted a system of penalties for the destruction of trees by burning or cutting. Although Alfred the Great modified these laws, it is clear that trees growing near townships had come to be regarded as advantageous to the community and were considered worthy of protection. The will to protect can hardly have extended far beyond the woods close at hand, except that 'king's woods', devoted to the chase, were a concern of the later Saxon rulers, who established forms of forest law in England some centuries before the Norman Conquest. Egbert, a ninth-century monarch, who has often been spoken of as the first ruler of all England, was lord of a number of hunting forests, and efforts to preserve game for his pleasure may, indirectly, have helped to conserve the woods. Subsequent incursions by Danes and Norsemen seem to have had little influence on the course of forest destruction; where these invaders settled the lands they occupied had already been cleared and cultivated by the people they displaced.

Glancing backwards into the dimly outlined past, it is not difficult to trace, broadly, the stages by which Great Britain first became a land of forests, and then to follow the steps by which all but vestiges of this wealth of primeval woodland have been lost—steps which are a commentary, perhaps, on the wasteful impact of rising civilizations on the riches of nature, which even the boasted culture of modern times has seldom sought to check until driven to do so by sheer necessity. Firstly we have the advance of a pioneer vegetation in the wake of the glaciers and glacial floods, and the gradual infiltrations of more highly organized species one

after another; the establishment of definite plant communities leading to the upgrowth of original forest types which were to change in character and composition under the influences of climatic variation and the laws of ecological succession; and later by the browsing of deer and wild cattle, and by the rooting of wild boar. The coming of man with fire and edged tools, to burn and cut his way into the woods, finally opened up the protective canopy and exposed the trees to the havoc of Atlantic gales. All these destructive influences grew in strength as time went on and men began to cut and utilize timber, and to clear more land for husbandry. Doubt has been cast upon the extent to which the total area of forest was diminished by the wars and conquests of the Dark Ages, beyond strictly localized fellings and burnings. Tales of huge destruction, and the clearance of extensive tracts of woodlands in course of the military campaigns are taken with reserve when we realize the tremendous labour such work involves. Fire was probably more destructive than the axe on these occasions, but deliberate burnings of mature forest, in a climate like ours, cannot always have been so easy as the results of the fires which break out in young plantations, in dry weather, sometimes seem to indicate.

The victory of Duke William of Normandy at Senlac forms a landmark in British forest history, perhaps the most conspicuous of all until, no less than eight and a half centuries later, Parliament passed the Forestry Act of 1919. It is due to the Norman monarch's passion for hunting, and his measures for the preservation of deer and other game, that a number of forest areas in England were granted a new lease of life and, indeed, added to, under the harshly administered code of Norman forest law. The true significance of the word 'forest' at this period has exercised the minds of historians and philologists, but it is clear enough that forestry, as we understand it, was not the aim, and that farm lands and open wastes were included in the 'afforestations'. The avowed object was sanctuary for beasts of venery and lesser game, although it is held by some historians that, in establishing personal sway over large tracts of country, the Conqueror may have had it also in mind to weaken the power of his land-owning followers. Scottish deer forests, in which red deer are preserved for stalking, offer the closest modern analogy to the Norman afforestations, including, as they do, large expanses of mountain and moor and relatively little woodland. Afforestation and disafforestation under the Normans did

not mean the planting or grubbing up of woods, but the reservation of land under forest law or its release from the ban. No one but the king could create a forest; favoured subjects had to be content with a chase, park, or warren, minor hunting-grounds which were not privileged beyond the scope of common law. Venison and vert, or wild game and their pasturage, were the considerations to the king and his barons; no man might kill the game animals of the period without the king's authority and penalties for infringements of the forest code were savage. *Purprestre*, or trespass and inclosure; *waste*, or the cutting of covert; and *assart*, or the grubbing up of trees for agriculture were all grave offences, but none was more grave than killing the king's deer. The site of an Asart Farm is marked on the ordnance map of Rockingham Forest to this day, and there are others similarly named about the country. Legendary statements that William I pulled down villages and churches to create New Forest are now rejected as fables. The process of afforestation was far more subtle than that. What really happened was that by forbidding inclosures, encouraging covert, and protecting game, cultivation within the ambit of the forest was made difficult, and farming had to give place to other preoccupations.

These matters provided fruitful causes of trouble between the king's officers and the local inhabitants and, on broader issues, between the people and the king. Domesday mentions five Royal Forests—New, Windsor, Wychwood, Grovely, and Wimborne—but there were others, some of which, such as Exmoor, Dartmoor, and the Peak, included great expanses of bare moorland. A number of ancient royal forests, all more or less greatly restricted in area, still survive—Windsor, New Forest, the Forest of Dean, Sherwood, Selwood, and the Chilterns are instances, and there are vestiges and recollections of many more. Some of the lands afforested after the Conquest have continued as Crown forests, and some have passed into the possession of other owners or administrators. How much of the Norman afforestations were actually woodland, and how quickly abandoned farms, rough grazings, and poor, barren lands reverted to forest by natural seeding, first by thorn and bushes and then by timber trees coming in under cover of the earlier growth of scrub, it is now only possible to guess, but it can confidently be said that the presence of many of the more extensive woodlands in England to-day is due directly to the operation of the forest laws introduced by the Norman kings.

It is significant that the final phase of destruction began with

the relaxation of the Norman code and the disafforestations that followed. Magna Carta, and later Forest Charters and Perambulations, weakened the severity of control and permitted the reduction of afforested areas. The next two hundred years was a time of continual struggle for the confirmation of these Charters, and although timber, even timber for building and rigging British ships, was being imported from as early as the eleventh century, and, before this, Spanish yew was in favour for bow staves, the growing demand for wood for everyday purposes pointed directly to a more careful conservation of home-grown supplies. Attempts made in this direction included a Statute of Inclosure, passed in 1482, and entitled 'An Act for Inclosing of Woods in Forests, Chases and Purlieus'—purlieus being lands already disafforested —to enable landowners to inclose to save 'the young springe of their woods'. This and other measures, together with forest surveys and contemporary writings, show the nation's awakening concern.

There was an illuminating preamble to the Statute of Woods of 1543 which ran: 'The King our Sovereign Lord perceiving and right well knowing the great decay of timber and woods universally within this his realm.' This Act was framed to prevent wastage and applied to the king's forests and private woodlands but, even so, denudation proceeded apace. It is possible to give too much weight to the effects of these laws because we cannot be sure how far the king's writ ran within the shade of the woods at this period. What is evident, however, is that the national conscience was then, as afterwards, very slow to awaken. Economic circumstances were responsible. There were clearances for cultivation, cuttings and burnings to provide grazings, fellings for fuel, for smelting iron and making glass, and for household purposes, and the drain on the nation's forest resources remained steady and severe.

The second half of the sixteenth century brought the national importance of timber supply again prominently to the fore, particularly in regard to ships' timbers and fuel. Taverner's Survey of 1565 tells us that the artificial regeneration of woods was already practised, and explains that planting then meant the setting or sowing of acorns, often with thorn and holly to give protection to the young oaks from grazing beasts; the formation of plantations by planting out young trees was a later development. Efforts of law-makers during the next two centuries indicate the failure of silviculture to keep pace with the increasing demand for wood for domestic fuel, manufactures, building construction, and the ship-

yards. As fuel, wood was replaced by coal only by slow stages; 'sea coales' did not win popularity speedily and, altogether, it is not surprising that the nation was frequently in straits for timber. Without active enforcement, the numerous Acts of Parliament and Surveys proved hopeless as a panacea for recurring anxieties, and the fact remains that at no time in our history has a concerted public effort to reafforest been sustained long enough to matter. For the most part the woods raised by sowing and planting since the close of the Middle Ages have been the work of private owners of land, a work to which the landed gentlemen of England were exhorted by John Evelyn who published his *Silva* in 1664. Helped materially by the growing prosperity of the times planting became fashionable within a few decades, and owners of private estates vied with one another in the adornment of their properties with plantations and trees. Introductions of exotic species gave additional zest to arboriculture, and account, in some measure, for the marked arboricultural bias afterwards discernible in English estate forestry. It is only fair to add that no one seems to have thought seriously of anything in the nature of a national forest policy; no State-sponsored forest service came into being until a bare quarter of a century ago, and practical encouragement was meagre or non-existent. Government aid was forthcoming in Scotland in 1713, and the Highland Society (afterwards the Highland and Agricultural Society), founded in 1783, did a good deal to foster an enduring practical interest in forestry. The London Society of Arts also awarded prizes for tree-planting at this time. Where rulers failed was in neglecting to bring home to the people of Britain the truth that forestry is part and parcel of a balanced scheme of rural economy, and in underlining the dangers that might beset a timberless country. Without facilities for forestry education and research, and for the accumulation of systematic technical knowledge, and without attention to markets for home-produced forest products such as some other European countries began to afford, the wonder is that unco-ordinated and purely private enterprise accomplished so much.

Except for the geological record and the evidence of the peat bogs, the ancient history of forests in Scotland is almost completely hidden. Peats yield abundant testimony of the persistence of pine forest in prehistoric times, often associated with birch and, in the West, with alder. Hazel was plentiful and oak was able to penetrate well into the valleys to the north of the Great Glen. It is

reasonable to assume that the same processes were at work as in prehistoric England, allowing for climatic conditions, then, probably more harsh. The cumulative effects of clearances for safety from human foes, wolves, and bears and, as the Bronze and Iron Ages, and succeeding cultures, made their way northwards, for tillage and grazing, together with devastations by invaders, and the warfare indulged in by the Scottish tribes between themselves for many centuries, cannot fail to have taken heavy toll of the natural forest. History does not begin to throw light upon the scene until the twelfth century and by then the South of Scotland was already badly off for woodland. In 1503 the preamble to an Act of the Scots Parliament stated bluntly that the woods of Scotland were 'utterly destroyed'. Richardson mentions the delight of a Scottish parliament of 1609 at the discovery of 'certane wodis in the heylandis'. Here, as in England, public need seems to have acted as a spur to public conscience, and from early in the fifteenth century laws were passed to protect woods and replace those which had gone. But forests cannot be brought into being by strokes of the pen, and later we have the comments of Dr. Johnson and other travellers on the treeless nature of the country, while Professor G. M. Trevelyan, in his *History of England*, states that Scotland, when George III began to reign, was hedgeless and treeless. Nevertheless, around the middle of the eighteenth century an interest in forestry developed, and the movement continued to gather impetus in spite of active resentment by dwellers in parts of the Scottish country-side against the planting of trees. From early in the nineteenth century onwards much planting was done, and the forests of native pine and other conifers raised by the Scottish lairds have been the principal sources of supply of home-grown softwood timber in the two World Wars.

In the years before World War No. 2, only 4 per cent. of the nation's requirements came from the home woodlands. Imports of timber into Great Britain, predominantly pine and fir, increased fivefold between 1850 and 1910 without corresponding stimulation of the production of home-grown plank and board. Even the pit-prop market, the natural outlet for the produce of silvicultural thinnings, was flooded with foreign wood. The principal reasons for stagnation in the home-grown trade were the abundance of relatively cheap foreign supplies of the kinds of goods required, the primitive methods of extracting timber from the woods, the high cost of rail transport, together with the intermittent flow of

raw material from home sources, and the unadaptability of so much of the material produced at home to modern commercial uses. It must be admitted that many estate-grown parcels have been over-ripe, knotty, and badly grown, moreover the species available were mainly hardwoods, whereas softwoods, derived from conifers, represent almost 94 per cent. of the total quantity consumed. Imports have varied in quantity and value year by year, and it is worthy of reflection that as much as £120 millions has been paid away to countries abroad for wood and wood manufactures in a single year, and that the cost of imported goods advanced heavily in course of the twenty-five years after 1913. The home woods are capable, under systematic management, of producing conifer timbers equal in quality to the Baltic brands in addition to prime oak, beech, ash, and elm, but the trees must be grown under correct silvicultural conditions and the timber properly converted, seasoned, graded, and marketed.

The Royal Arboricultural (now Forestry) Societies, founded in Scotland in 1854 and in England in 1881, have fulfilled a public service in helping to keep the flag of forestry flying but, in spite of their work, and that of the small body of knowledgeable enthusiasts for British forestry, timidity and procrastination, depicted only too plainly in the rapid succession of Reports issued by Commissions and Committees of Inquiry from 1885 onwards, continued to burke the issue. This unsatisfactory period culminated in the monumental Report of the Royal Commission on Coast Erosion and Afforestation in 1909, in which alternative forestry schemes, both extensive, and the appointment of a Forestry Board, were advocated, but, even at this late day, the approach to the problem was rather from the newer angle of employment than of timber production. However, in the same year, the Development Commission was authorized to devote its attention, in part, to forestry. Things were beginning to make a move, but at this stage caution was well advised. It was recognized that State Afforestation could not promise success until it had been demonstrated where, in the kingdom, forests could be planted remuneratively, and until wider plans for education in the art and science of forestry could be formulated and put into effect. So far as slender funds allowed, valuable work was done. Experimental areas were acquired at Dymock, in Gloucestershire, Hafod Fawr in North Wales, and Inverliever in Scotland, and systematic management was imposed in certain of the Crown Forests, notably in the Forest of Dean,

Tintern, New Forest, Salcey, and Alice Holt. Training of foresters was also put in hand in a modest way and courses for forest officers were improved and extended at University forestry schools. A further step in the right direction was the inauguration of a small Advisory Service to assist woodland owners. Meantime public opinion was gradually crystallizing in favour of a national forest policy, which, alone among the forested nations of Europe, we still lacked. Finally, after 1914 the moral was pointed unmistakably by the German sea-raiders in terms none but an utterly foolish people could possibly misinterpret. A Reconstruction Sub-committee was set up after two years of war, presided over by Mr. F. D. Acland, M.P.,[1] a woodland owner and forestry stalwart, 'to consider and report upon the best means of conserving and developing the woodland and forestry resources of the Kingdom having regard to the experience gained during the war'. The Report of this Sub-committee, since known as the Acland Report, was accepted, and the Forestry Act, 1919, creating an independent Forestry Commission, was passed with the assent and goodwill of every shade of political opinion in both Houses of Parliament. So, after centuries of indifference and vacillation on the part of kings, parliaments, and people, and of individualistic and empirical effort in the maintenance of most of the privately owned woods, a national policy was at long last brought into being, giving promise of that continuity which is the prime consideration in any long-term undertaking such as the creation of forests for the production of timber trees.

The Forestry Commission has survived the vicissitudes and financial instabilities of the past twenty-five years and now that the scourge of a second World War has fallen upon us, the lessons of 1914–18 are found to be underlined in their entirety. In their Report on Post-War Forest Policy,[2] 1943, the Forestry Commissioners have published a concise account of their stewardship and their recommendations for the future. For the safety and well-being of this Island Realm it may be hoped, contrary to all past experience, that reason, determination, and continuity will henceforward prevail in this country as long as forests and forestry retain their indispensable position in the service of mankind.

[1] Afterwards the Right Honourable Sir Francis Dyke Acland Bt., M.P.
[2] H.M. Stationery Office, Cmd. 6447—1943.

Chapter 2

BRITAIN'S WOODS AND TREES

If woodland be our theme, let our woods be worthy of a consul's ear.

VIRGIL

We are, at heart, a nation of sentimentalists, and where woods are concerned British sentiment clings to symbolic conceptions of woodland and forest, so deeply rooted as to have become conventional. Forest tradition peoples the woodlands of Britain with heavily crowned oak, spreading beech, ash, and birch trees, old, gnarled, and ivy-clad, or clean and in full vigour, growing amid an underwood of lesser trees and bushes, with trailing honeysuckle and briar. Deep-rutted rides criss-cross the woods, opening out here and there into broad grassy glades and clearings, bordered with wild flowers and fern. The sylvan depths, sweet smelling and green in the sunshine and shade of summer-time, and leafless and austere in winter, are filled at all seasons with strange sounds and silent fancies, entrancing, and in some degree awesome to the boldest imagination. Woodlands of the types associated with medieval romance are still to be found almost unchanged, or in the more stereotyped form of coppice with standards, in many parts of the country. The species are broad-leaved and deciduous, excepting the evergreen holly and, on limestone and chalk, the sombre yew. In the North, pine and birch take pride of place, and survivals of natural pine forest still grow on in upland regions beyond the Highland Line. But, for the most part, forest tradition has been perpetuated by artificial plantings, in which pine and other conifers have become prominent features in addition to broad-leaved species, and in spite of sentiment and memories we are obliged to admit that the woodlands of Great Britain have, for centuries, been undergoing a slow process of change, due to progressive alterations in fashion and the utilization of forest products, and to introductions of exotic species. It has also to be realized that the national value of woods, such as those known to Robin Hood and his merry men, and the old charcoal-burners and faggot makers, has also undergone change. The story was a different one in the heyday of rural handicrafts and when wood was relied upon as fuel, in times when the growth of coppice stools could be utilized in the old ways, and in days when heavily branched oaks were needed to supply knees and bends, as well as plank to the shipyards.

As time-honoured forms of wood utilization fell into disuse, silvicultural interest also became less, and with it the incentive to maintain production from types of woodland which could no longer hope to pay their way. Is it to be wondered at that signs of silvicultural neglect began to show themselves in so many of these woods? And even when old-time types of woodlands have been taken in hand from motives of amenity, sport, or profit, results have accorded fairly consistently with the bias and quality of the management meted out to them, and have not always produced stands of timber best fitted to fulfil their function as part of a national timber reserve. Now that the need to devote British woods to timber production is forced upon us by the impact of two merciless wars, dedication to any other purpose than the growth of timber trees is unthinkable, except as a secondary consideration. Woods of open-grown, short-boled, heavily branched oaks and beeches; coppice, other than chestnut coppice for fencing pales and poles; and unthinned, untended plantations have had their day. But, in spite of survivals of ancient forest, and however closely some of the remaining woodland may resemble its prototypes, it is only a slight exaggeration to say that all the woods and forests we now know in Great Britain are of artificial origin, and have been planted by the hand of man. The venerable appearance of old woodland is often misleading. Genuine survivals of once widespread primeval forests are few and far between; they have gone down before the slow, persistent forces of decay and the busy axe, while hopes of natural regeneration have been destroyed by the all-devouring rabbit, and by grazing animals and fire. Nevertheless, numbers of woods, replanted in past centuries and more recently, occupy land which has been woodland from time immemorial. The Forest of Dean is a case in point and, under the Forestry Act of 1919, land has been reafforested in the ancient forest areas of Savernake, Rockingham, Sherwood, Selwood, Wyre, and others. The presence of primroses, wild hyacinth, or wood anemone is a fairly reliable indication of former forest conditions and, where these woodland flowers are found in what is now open country, the inference is strong that the district was a natural forest at some earlier period.

When the second World War broke out in 1939 the aggregate area of woods in Great Britain had shrunk to a little over 3 million acres, a total which included all woods, plantations, coppices, scrub, and woodland already stripped of its utilizable trees. Woods and forests occupied only a fraction over 5 per cent. of the land surface

of the country, and a woefully small proportion of this woodland was productively economic. After deducting the partially productive and completely non-productive areas, the effectively stocked forest remaining did not amount to much over 2 per cent. of the acreage of the whole country. A comparison with the position at the time of some of our continental neighbours is enlightening. Forests covered 27 per cent. of German territory, and Germany was a timber-importing nation; France possessed 19·1 per cent. of forest; Holland and Denmark, two of the smallest of the European kingdoms, had 7·8 per cent. and 7·5 per cent. respectively; and in Belgium, another very small but densely populated land devoted mainly to manufacturing, forests extended over no less than 18·4 per cent. of the total area. And actually none of these nations was completely self-supporting in regard to timber supply. Professor A. G. Tansley, writing in 1939, stated 'the British Islands have a smaller proportion of their area occupied by woodland than any other country in Europe': other writers have stressed the position, far from a happy one for an island nation, dependent, except as to a mere 4 per cent. or so, on timber and wood products brought in ships from overseas. The full tale of the drain upon the home woods in the two war periods, and in the years between, is still to be told and, progressively poor in home-grown timber resources as we had become by 1939, it is no alarmist statement to say that the position has since fallen to such depths that the barest margin of a safe reserve will not be fully regained in our time.

Until recent years many of the most important principles of systematic forestry remained almost unknown quantities in Great Britain. The work of planting and tending woods, so far as it was done under any system at all, was based chiefly on continental practice, and methods adopted by the French, Swiss, and Germans in their forests, excellent as they are in their respective countries, are not wholly suited to our insular climate and peculiarly varied soil conditions. On the whole, it is not surprising that the principal objective of forestry, that is the production of timber, has so frequently been overridden by other influences, the consequences of which have left their unmistakable mark. In general, no proper distribution of age classes has existed, and there has been no regular order of exploitation. Management has varied according to individual inclination; and maintenance of covert and conservatism have encouraged the retention of timber trees beyond their prime, besides leading to an almost universal neglect of

1. *Coppice with Standards, formerly a profitable system of English*

S. E. WILSON

2. *The Wages of Neglect: an untended Scots Pine Wood*

silvicultural thinning. Too frequent a hesitation to cut timber, over-ripe or otherwise, except on occasion, or for the purpose of 'raising the wind'—after the manner of Pepys's nobleman, who considered trees to be 'an excrescence of the earth provided by God for the payment of debts'—has provided many examples of over-mature timber and degenerated woodland. The low prices obtainable for produce, and reluctance to disturb the quietude of the coverts by carrying out essential forestry operations, have been other root causes of much bad silviculture in which omissions to thin growing plantations in proper season have, perhaps, been the greatest blots. It is a question of national, not of individual, blame; such as it is, the fault lies in a general acceptance of *laissez-faire* as a policy in lieu of a national forest policy. It is also necessary to appreciate circumstances as they were before the vital necessity of maintaining reserves of standing timber within the country began to be brought pointedly home to the British people. The lengthy period of prosperity, which lasted to the turn of the twentieth century, and a myopic desire to let alone what was deemed to be well, have tended to confuse the true function of national forestry, and to relegate to the background considerations of system in forest management. And yet, in spite of shortcomings, and there have been many, much has been accomplished in private woods with private funds; and, with the barest minimum of public encouragement, the landowners of Britain accumulated on their properties the reserve of home-grown timber which has been drawn upon so freely, twice within twenty-five years, in the emergency of war. If system has so often been lacking in estate forestry, trial and error taught many things in bygone years, and the pity of it is that so much locally gained silvicultural knowledge has gone unrecorded.

The fortunes of Britain's woodlands, century by century, since the Middle Ages, have naturally followed the graph of national prosperity. Fashion has played its part in changing the character of forests as well as time and money. Utilizations also change, and descriptions of timber and minor forest products which meet the requirements of one period have seldom proved of equal value in other times. In turn, new ideas and purposes become reflected in the nature and composition of the woods; change is, in general, almost imperceptibly slow, but it can also be abrupt, as when cut-over woodland is replanted with entirely different species. The practice of planting oak and other hardwoods with

conifer nurses, usually Scots pine or larch, has been the means of introducing a good deal of mixed woodland into the landscape, and plantings with the deliberate intention of forming a mixed crop have also been frequent. A number of trees, broad-leaved and conifer, have been introduced at different periods, and planted in British woods in the place of native species. The use of acclimatized conifers was strongly influenced by Evelyn's famous book, *Silva*, and many of these exotic species are noble forest trees which have added to the dignity and utility of our forests. A love of trees, if not always of particular trees in particular places, is inborn in the British race, and as an abstract term, forestry has also a wide appeal, deriving no doubt, from legend and literature and the romance borrowed from Scandinavian and Germanic folk-lore. One of the influences of Evelyn's teaching, and the interest taken in the many new species brought from other parts of the world in his time and after, helped to develop a leaning towards arboriculture in estate planting, and care for the tree has in not a few cases led to neglect of the wood. In the economic and military aspects of forest policy, popular judgement has been less clearly led, and it is far from generally realized that timber trees are as much a crop as any other cultivated plant, also that the business of growing trees is a branch of husbandry. The forest-mindedness that is so conspicuous a trait among certain European peoples has not yet found its counterpart in modern Britain.

Since the industrial revolution and the concentration of progressively increasing populations in large towns, urban interests have been paramount and wood (foreign wood) has been readily available to satisfy everyone's need for timber. Another point is that access to private woods has not often been invited save by favour; the German *verboten* has hardly been more obviously displayed than woodland notices threatening pains and penalties to trespassers. Nowadays, when these legally futile notice-boards fall into disrepair, they are not always renewed, but the time is not so very remote when man-traps were set in English woods to catch the venturesome and unwary; woodland warnings 'Beware of man-traps and spring guns' can still be remembered by the older generation of country folk, although, in spite of one case quite recently before the Courts, the unkindly practice of setting snares of this sort may now be said to be a thing of the past. Woods and forests must be known before the aims and objects of forestry can be understood.

An abundance of trees glorifies the British country-side, a circumstance that accounts, in considerable measure, for the lack of comprehension, and absence of perspective, in matters relating to national forestry. It is a paradox, but our undoubted poverty in respect of forests has been effectively screened by the widespread wealth of arboreal beauty in our hedgerows, spinneys, and parks. It cannot even be claimed that Great Britain is well off for native timber-producing species. They are few indeed. Oak, ash, and beech are the valuable hardwoods, and Scots pine is the sole native softwood tree of commercial worth. Indigenous trees of more limited utilizable value are birch, alder, hornbeam, elm, cherry, aspen, poplar, lime, willow, yew, with some others of little but scenic and botanical importance. All these species find place in typical British woodland, but without trees from other parts of the world, particularly some of the fast-growing conifers, British forestry would be at a serious disadvantage in the task of mending the war-devastated woods, and in making provision, as quickly as may be, for future security.

We live in an age of softwood utilization and the insatiable demand is for the timbers of conifer trees. Of these, none is superior for general purposes to our own Scots pine, a tree which stands high in the estimation of all British foresters and of the timber trade. Our one native pine is seen at its best amid mountain scenery, as in the forests of Deeside and in the valley of the Spey. But, all the same, some of the finest Scots pine in Great Britain stood until recently in Black Park at Langley, in Buckinghamshire, and there are (or were) many fine stands in New Forest and elsewhere south of the estuaries of the Forth and Clyde. No one can deny the rugged beauty of this native conifer with its warm, red-barked bole and rich bluish-green crown, nor decry the qualities of its timber. But the tree that is characteristic of Britain above all others is the English oak. Two species of oaks are indigenous: the pedunculate oak, bearing almost stalkless leaves and acorns with long stems or peduncles, and the sessile or Durmast oak, with its acorns sitting closely on the twigs, and its leaves with noticeable stalks or petioles. The two species grow side by side in a number of localities and, as they hybridize freely, intermediate varieties are common. Celebrated in history and folk-lore from the days of the Druids, English oak has long been recognized as an emblem of British might and tenacity. Slow in growth, deep rooted, tough, and strong, oak timber formed admirable material for the

patient craftsmen of the old days, but is not now so well adapted to modern industrial uses. Both our native oaks produce timbers of great durability, and although the builders of the old Ships of the Line expressed preference for pedunculate oak, tests prove that there is little to choose between timbers of the two kinds. It may be that the greater accessibility of the favoured species to the principal ship-yards had something to do with the preference. One quality possessed by sessile oak which ought not to be overlooked by silviculturalists is its relative immunity from the ravages of the insect defoliators, the *larvae* of oak tortrix and winter moths.

Some famous oaks stand in the English woods and parks, and there are records of many others. Trees considerably over 30 feet in girth have been measured and heights of over 100 feet are recorded. The species can attain great age. The series of well-defined concentric annual rings visible in a cross-section of the butt of a felled tree is a sure indication of its age. Thus, at the average rate of only ten rings to an inch, an oak 30 feet in girth can be reckoned as having stood for six centuries, and such a tree might, in fact, be a century or so older because, with the approach of age and as girth increases, the peripheral rings laid on by each successive season's growth are apt to become very narrow. Domesday Survey says little or nothing concerning trees, but local legend credits individual oaks and yews—the latter are the longest lived of our native trees—with ages of a thousand years and more. In actual fact, survivals even from so far back as the Norman dynasty must be very rare indeed, and popular tales of the longevity of individual trees in Great Britain are often overstated. If milder timbers have to a great extent usurped the place of British oak in British industry, no forest tree grows in our woods that is more sure of its place in the hearts and affections of the nation.

Ash and beech are the other most valuable of our native hardwoods. Ash grows at its best when standing singly or in groups in mixture with other species provided the leafy canopy overhead is not heavy; without direct access to light, ash cannot flourish. In a moist, fertile soil, particularly where lime is present, ash develops a long, clean stem and produces springy, resilient timber; in the full panoply of its pinnate, feather-like foliage the tree possesses an unequalled grace of form, but its leaves are usually slow to flush in spring, and fall at the first touch of autumn frost. Beech, on the other hand, grows to perfection if densely massed. Many other

trees thrive in mixture with beech, which is recognized as a protector and improver of soils on account of its dense overhead canopy and rich, fertilizing leaf-fall. For these reasons and because, in favourable conditions, it regenerates itself freely from seed, this tree is known in Germany as the 'Mother of the Forest'. A beech-wood is a glory at any season of the year. The long aisles of lofty, ash-grey boles with interlacing crowns glowing purple in the late winter's sun, the delicate spring greenery of the newly flushed leaves, followed by the darker hues of the summer leafage, and the yellows and reddish-browns of autumn present a continuous charm and beauty of tint unsurpassed by any other of our forest trees. The Chiltern and Cotswold beeches are famous. In the Chilterns, beech-woods have long been managed on the *Selection System* of forestry, a method held in high regard by many continental foresters but not practised on a large scale anywhere else in Britain. Individual trees are periodically cut and utilized as they become mature, their places being filled by natural seedlings or by planted trees, and as beech tolerates considerable shade when young, the young seedlings grow up readily under the protection of the surrounding shelter-wood. In this way a stock of growing trees is maintained in which all age classes are evenly represented throughout the wood, and the ground is never completely exposed by a clear felling. Beech timber has many commercial uses, and its cultivation is likely to be extended in future years.

Birch, the 'Lady of the Woods' of the poets, can almost be considered the Cinderella of British forestry for its silviculture has been neglected. Two birches are indigenous—the smooth-stalked silver birch and the hairy or pubescent species; there is also a host of intermediate types due to hybridization. None of our forest trees is more graceful and beautiful at any season of the year than a silver-stemmed birch, drooping its fine, pendulous branches in open woodland. It grows abundantly throughout the country on the poorest of soils, and seeds so profusely that it has usually been treated as a forest weed. It is hardy, fast growing and, when young, vigorous, but has not a long span of life, nor does it attain the impressive size of the more important broad-leaved species. Well-grown birch trees from British woods might profitably take the place of the birch logs now imported from abroad. The tree is certainly worth a better status in British forestry, and it should not be beyond silvicultural skill to produce healthy, cylindrical boles of sizes suitable for veneers and plywood. Russian, Swedish, and

Finnish birches, which supply a large part of the plywood material hitherto imported, are identical as to species with our own trees. Birch timbers are also imported from America, but from entirely different species of the genus *Betula*.

Of the other native hardwood trees which add to the charm and diversity of our woods, none is of sufficient economic importance to warrant cultivation on a large scale. Alder, hornbeam, lime, aspen, and willow all have their uses but scope for utilization is in each case limited. The native abele and black poplars are surpassed by the black Italian and other more vigorous poplar hybrids. Wych elm, which supplies an excellent timber of great resilience and grows well in many parts of the country, is rarely treated as a forest tree, nor is the common elm of our hedgerows and parks. The gean, or wild cherry, valued for the beauty of its white blossom and its autumn foliage, produces a useful timber, and is frost-hardy when young, a valuable attribute, as most of the indigenous hardwoods of economic and aesthetic interest are frost-tender in their early years.

From the dawn of the Christian era, and quite possibly earlier, the scanty list of truly indigenous British timber trees has been augmented by introductions from the Continent and from other parts of the temperate world. These newcomers have brought about changes in the character of the woods, and some of them have affected profoundly the course of British forestry. Without Spanish chestnut, larch, Norway spruce, and Corsican pine from Europe; sycamore from the Near East; Sitka spruce, Douglas fir, and the Western silver firs from the Pacific sea-board of North America; and another larch from Japan, to mention only the most important of the exotic species, forestry in this country would be badly handicapped in the task lying ahead. Some arrivals of a very early period were Spanish chestnut and sycamore. Nothing authoritative can be told of the origin and status of the English elm, which, unlike its cousin, the native wych elm, only matures fertile seed on rare occasions in its present habitat in Great Britain. When and how this tree first gained a foothold in England and where it came from are among the mysteries of forest botany, and *Ulmus campestris* may yet be accepted as an indigenous species. The introduction of Spanish chestnut, sycamore and others, including walnut and mulberry, is credited to the Romans, but there is no historical record, and it cannot be said with certainty that the responsibility was theirs. Many things have been

attributed to the Roman colonists by naturalists as well as historians, and we may well leave the onus of bringing these trees into Britain, such as it is, on their broad shoulders. Since Tudor times introductions of new species have followed in a steady stream; in the eighteenth century alone Loudon records that nearly five hundred different kinds of trees and shrubs were brought to our shores. Norway spruce came in early in the sixteenth century and European larch about a hundred years later. Evelyn mentions a larch tree 'of good stature' at Chelmsford (*circa* 1662). No tree of foreign origin has been more widely planted in British woods than the common larch, and the extensive plantings of the 3rd and 4th Dukes of Atholl, from 1727 onwards, on their Perthshire estates, did much to popularize the species and add to our knowledge of its silviculture. The common silver fir (*Abies pectinata*), a noble European tree, is believed to have been grown in this country for at least three hundred years. Unfortunately, in recent years, an insect of the plant-lice group, *Dreyfusia abietis*, has attacked this tree severely in the western half of Great Britain and for the time being the planting of common or silver fir has been given up. It is to be hoped that a place in modern silviculture may yet be found for this useful tree. Weymouth pine, the source of supply of American white pine timber, was acclimatized in 1705. At first it grew successfully but later this tree also failed in our woods. It succumbs to a bark-blistering fungus, the alternative hosts of which are plants of the genus *Ribes*, and, while currants and gooseberries are cultivated in our gardens, and the popular flowering currant in our shrubberies, it is useless to plant Weymouth pine as a forest crop. Corsican pine was first planted here in 1759.

In the course of their plant-hunting expeditions between the years 1792 and 1834, the Scottish botanists Menzies and Douglas discovered and sent home several important species from Western America including the giant silver fir (*Abies grandis*), the noble silver fir (*A. nobilis*), and, best of all, the Douglas fir, the Oregon pine of commerce, which Douglas introduced in 1827. This intrepid plant collector lost his life in 1834, in the course of his botanical explorations, but the imposing conifer that bears his name will for ever keep his memory green. The coastal or green variety of Douglas fir is a truly magnificent timber tree, and in favourable conditions in its new surroundings it grows rapidly in height and girth; trees up to four hundred and twenty cubic feet in content have been grown in the New Forest in eighty years. On

the other hand, the blue or Colorado Douglas fir is disappointing in its growth in Great Britain, and is prone to disease. Other valuable Western American species have been brought over: Sitka spruce, already recognized as an extremely valuable acquisition to British silviculture, and the Western hemlock (*Tsuga heterophylla*), perhaps the most graceful of all the conifers, both arrived in 1851; the giant thuja became known in 1853, and Lawson's cypress in the following year.

Seed of Japanese larch was first imported in 1861. This excellent larch grows quickly in areas of moderate to high rainfall. It is remarkable for its virtual immunity from larch canker and appears to have hybridized with the common larch to produce what, to all appearances, is a faster growing, and more satisfactory, addition to our timber-producing conifers than either of its reputed parents. The Balkan spruce (*Picea omorika*), which we received in 1875, shows signs of being less tender to spring frost than its congeners, but is not equal to Norway or Sitka spruce as a timber producer. California's two big trees, the redwood (*Sequoia sempervirens*) and the Wellingtonia (*S. gigantea*), are comparatively late comers. The former reached England about 1843 and the latter in 1853. Their deep red timbers are light and soft but are produced very quickly indeed, and forests of these spectacular trees may yet be raised in the coastal valleys of Western Britain. It is a curious fact that, while the best of the timber trees, all conifers, from western North America, almost all grow freely and well in appropriate parts of Great Britain, the numerous forest trees of value from the eastern side of the North American Continent, including many broad-leaved species, mostly fail in vigour, or else fall victims to disease, when planted in forest conditions in this country. It may be that our insular climate, with its damp winters, late spring frosts, and cool summers, does not suit these trees, accustomed as they are to the rigorous winter weather, short spring, and hot summer of their native habitat.

Introductions of exotic plants and trees are often deprecated by botanical and aesthetic purists, and from the standpoint of British field botany it is possible that there may be some reason on their side. Forestry, however, involves wider considerations, in the same way as farming does, and agriculturalists would not dream of limiting themselves to the cultivation of native food plants. Foresters are equally entitled to stock their forests with the most suitable species of timber trees at their disposal. Without trees such as

Sitka and Norway spruces, Douglas fir, and Corsican pine, the replenishing of our vanished timber resources would be immensely prolonged. Moreover, without the spruces, none of which is a native tree, many thousands of acres of the poor, sour, peaty moorlands of Great Britain could not profitably be afforested, and the planting that is necessary for national safety would perforce encroach on lands of better quality. We do not possess a native tree which can compete, in volume of production, with the introduced spruces and pines, particularly on the least productive types of land available for afforestation, but it is comforting to know that there are many sites and soils, best suited to the indigenous oak, ash, beech, and Scots pine, on which these British trees are in no danger of being supplanted.

If the nation's deficiency in forests is to be made good, there must be afforestation of bare land. There must also be new plantations. Newly planted trees, broad-leaved or conifer, native or exotic, may be unattractive in the landscape, but it is a temporary phase and, as pointed out elsewhere, not many living things, except kittens, are seen to advantage in early development. To adopt another analogy, in due course the naked fledgling becomes a full-feathered bird and, equally, the despised transplants develop aesthetic dignity as timber trees. It is necessary to plant young trees close together, in an orderly way, if they are to grow into tall forest, and imagination is sadly wanting, not to mention appreciation of the national need, where the future forest is condemned from the stereotyped appearance of new plantings. Trees are slow growers and the processes of growing them require patience and time. It may be that the mellowing influence of time is sometimes overlooked.

Chapter 3

FORESTRY IN OUTLINE

Come forth into the light of things,
Let Nature be your teacher. WORDSWORTH

FORESTRY is the art of growing rotational crops of timber trees in forests and woods. Forests are tracts of land devoted to the growth of trees, and the clearest description of a forest is that it is a very big wood, or a series of large woods, cultivated and managed for the production of timber, bark, resin, seeds, and all the other items of minor produce we derive from forest trees. The purpose of systematic forestry in Great Britain is, firstly, the creation of an adequate reserve of growing timber within the country and, secondly, production by annual cuts of timber suitable for conversion by woodmen and sawmillers into various utilizable forms, ranging from baulks and deals to poles and pit-props; material of descriptions hitherto almost entirely obtained from abroad.

If the ways in which trees have grown up in the home woods and coverts have not always been strictly according to system, a large store of growing timber has, nevertheless, been produced for which, as a nation, we have had every reason to give thanks. Two principal systems of forest management are recognized by British silviculturalists: High Forest Systems, in which crops are normally of seedling origin; and Coppice Systems, including coppices with standards, in which successive crops originate, in part at least, from coppice shoots or by other vegetative means. The high forest systems are our main concern because the coppice woods in this country have lost the important place they once held in our rural economy, and are increasingly being converted to high forest.

High forest systems fall into three main groups: *Clear Cutting*, in which the crop of old trees is cleared by single fellings, the resulting crops being even-aged; systems of successive regeneration in which the old crop is cleared by two or more successive fellings—the Uniform Group and Strip Systems come into this category; and, thirdly, the Selection System, in which felling and regeneration are distributed over the whole forest and the crop, as a whole, is uneven-aged. The last of these systems approximates most closely to nature's way of perpetuating a forest, and is to be seen in operation in the Chiltern beech-woods. Variations, adapted to local circumstances and individual species, are based on one or

another of the foregoing systems but in every case the underlying principles are constant. Periodic fellings, regulated as to quantity by the amount of wood the forest is producing, are followed by correspondingly regular regeneration. If the volume of timber felled does not exceed the increment, and provided the stock of growing trees is continuously replenished, it follows that such fellings can continue indefinitely because the volume of wood removed is always renewed in the meantime. This is the principle on which foresters maintain their ideal of *sustained yield*, a consideration that is fundamental in sound forest management.

To keep a forest continuously stocked with growing trees to the full capacity of the ground, a gradation of age classes must be assembled throughout the area, from seedlings, or newly planted-out nursery stock, to mature timber trees awaiting the axe. The rule is to manage a forest on a fixed rotation, the period of which may be short or long according to species, locality, and the kind of produce desired; the duration of a forest rotation is determined by the length of time required for the trees to grow to the dimensions desired. For conifer pitwood, in favourable conditions of soil and climate, a rotation may be as short as twenty years, whereas rotations up to several hundred years are not unknown where broad-leaved species are left to grow on to make really big timber, as with the famous oaks in the Forest of the Spessart in Bavaria. In a forest systematically managed on an area basis, and worked on a rotation of (say) seventy years, one-seventh of the total acreage will, at any given period, be stocked with trees up to ten years old; a similar extent of ground will bear trees aged eleven to twenty years, and so on up to the final age-class of sixty to seventy years which includes those trees due to be removed in the next *coupe*. On this basis, if x is taken as the total acreage of the forest, the area it is proper to fell in each year is $x \div 70$ acres. The argument presupposes an established and fully stocked forest on which to work, and, of course, when forestry makes beginnings on bare land, as now necessary in Great Britain on so extensive a scale, patience must be the order of the day until a series of properly stepped-up age classes can be built up, that is until a correctly disposed stock of standing trees has been accumulated on the ground with which to conduct the business of forestry.

The common-sense wisdom of limiting the quantity of timber withdrawn from the undertaking to the amount of the current increment is sufficiently plain. To take away wood faster than the

trees are laying it on is to draw upon the reserve of capital stored up in the succession of age classes which, with the forest soil and existing improvements such as roads, bridges, &c., represents the total capital investment in the enterprise of timber production. To cut into capital is accepted as spendthrift policy in any business. The annual increment of a forest is the aggregate volume of new wood formed by the seasonal growth of all its trees. The quantity is measurable by reference to the height and girth of the trees, and the yearly increment in a healthy, well-stocked forest amounts to anything up to 100 cubic feet per acre; in exceptional circumstances, or with the faster growing species, it may be much more.

It is a truism to say that those who set out to wrest a primary product from the soil never cease to learn something new about their work and, in spite of great progress in recent years, foresters continue to tread a path bestrewn with fresh and intricate problems, often interdependent, and always difficult to unravel. Nature, too, is jealous of human meddling that may run counter to elemental laws, and in forestry, as in all other forms of production from the land, mistakes have a sure way of coming home to roost. In this farming and gardening are closely akin to tree growing, but there is the important difference that field and garden crops are sown and harvested within a short season and opportunity is constantly occurring to correct and improve methods of cultivation and cropping, whereas foresters seldom live to see the full growth of the crops they plant and initial mistakes cannot so readily or so quickly be put right; indeed, the object lesson of an early silvicultural misjudgement usually remains in full view for the term of a long rotation.

Like agriculture, modern forestry is deeply indebted to the sciences which render the same degree of service to practical forestry as they do in the production of field crops. The application of scientific principles to the making and conservation of forests is, however, an even newer thing. Technical education in forestry was unknown in Great Britain until 1885 when Dr. (afterwards Sir William) Schlich, Inspector-General of Forests in India, came to England to open the first organized school of forestry in the country at Cooper's Hill. This forestry school was transferred to Oxford University in 1905 and, three years later, courses at Cambridge and Edinburgh were also instituted for qualification in forestry. Cambridge University has discontinued her forestry school, but instruction is now also provided in the Universities of

Aberdeen and Wales, the latter at the University College of North Wales, at Bangor. In some of its practical aspects the teaching in the Universities has not hitherto covered all groundwork required for the successful practice of forestry in Great Britain. This is understandable because, for many years, graduates could find employment only in the Indian and Colonial Forest Services and University courses were naturally framed with a definite tropical bias to meet conditions very different from those at home. But now that forestry has become the object of serious policy in Great Britain, the outlook has broadened, and subjects essential to the successful establishment of forests in this country are to be given more prominence, notably principles governing land management, and law in relation to landed property; the study of business methods and utilization as applied to forestry and forest products in Great Britain; and the elements of public administration. In an old-established country like ours, law and custom bear closely on all dealings with the land; landlords, tenants, and the public have each got firmly established rights and privileges which must be understood and allowed for at every turn. Without a grounding in the principles of land-agency it is impossible to acquire and adapt land for afforestation without treading on somebody's toes. A study of business principles, and of dealings between man and man, are necessary, and the elements of public administration are equally important. So also are methods of utilization and marketing, and ways and means of encouraging interest in the natural history of forests and the influence of birds and beasts on the growth of trees and the control of pests.

As might be expected, earlier beginnings were made in technical education in the more forest-conscious countries of Europe. German and French foresters were the first to adapt the discoveries of science to the growing of timber trees. Forestry schools and University training in forestry became available in Germany early in the nineteenth century and in France not many years later. Stations for technical experiment were founded in Germany as early as 1863. The practice of forestry has since become systematized in all the leading countries of the world on the broad bases of scientific research, experiment, and observation, because, to obtain the best practical results, theory and practice must march closely together as they do in the wider field of agriculture.

All forms of husbandry, including forestry, are bound to the soil and turn to the science of geology for information concerning the

structure of the earth and the rock formations from which, by weathering and attrition, the surface soils are formed. A more modern science, pedology, teaches of soil compositions, textures, and inherent qualities. Knowledge of the properties and productivity of different soils, and the influence of subsoils on fertility, are matters of prime importance in the cultivation of land whether the intended crop be wheat, vegetables, or trees. In most countries forestry is relegated to poor and relatively barren soils, and many of the afforestable lands of Great Britain have lain undisturbed by any previous form of cultivation since they were first deposited by the retreating glaciers, for the simple reason that it has not previously been worth anyone's while to attempt to till or improve them. Gradually, however, economic pressure is compelling wider and fuller utilization of British soils as with the soils of most civilized countries; future circumstances are likely to compel more careful attention to our extravagantly large areas of rough, unproductive, or partially productive land.

The labours of botanists, biologists, and zoologists form part and parcel of work so intimately concerned with the lives and habits of plants and animals as forestry. Entomologists identify the insects which infest and injure forest trees and, by working out the often exceedingly intricate life-histories of these pests, help in the control of their activities. They indicate also the predatory species whose function it is to prey on other kinds including some that are troublesome. Mycology assists in the same way with fungi, of which many are injurious to growing trees and to timber before and after the processes of seasoning, conversion, and processing. Mycologists tell also of the organisms and *mycorrhizae* that are friendly or otherwise to forest growth. Too much stress can hardly be laid on the value of ecological research to forestry. Ecology, a relatively modern science, deals with the ways in which living things behave in association with one another in nature, and interprets the mutual reactions of one with another in natural surroundings, and the effects of artificial interferences. Plant and animal ecology brings into focus the meaning and function of this species or that in a natural community of different forms of life, and points to the 'indicator' and 'pioneer' plants, the presence of which often gives a key to the possibilities of the soil and locality, and to the selection of the right kinds of trees to plant. Ecology also helps to show how an artificially introduced species may be expected to fare in given circumstances of environment.

Chemistry yields knowledge of the elements and physics of the elemental forces, by which trees draw nourishment from the soil, water, and air. These sciences explain what wood is and what its components and qualities are, and how, by widely differing processes, the produce of forests can help to meet demands for raw material to satisfy the never halting march of discovery.

Climatology and the effects of wind and rain, frost and snow, heat and cold, sunshine, shade, and drought are studies of deep significance in all attempts to make things grow. Island climates differ from those of continents in many respects. Continental countries depend on direct sunshine and warm air currents for their heat, and temperatures vary from winter to summer—and even by night and day—much more widely than in lands that are insulated by large bodies of water. The degree and distribution of moisture is also more reliable as to quantity and regular precipitation on an island than over great continental land masses remote from littoral districts. The British Islands are fortunate in that they share in the great natural hot-water system of the Gulf Stream. This warm ocean current flows northwards around the western seaboard and exercises profound effects on the climate of Great Britain. The modifying tendencies of oceanic influences on temperatures are also very marked. The latitude of London lies north of that of Quebec and the Canadian prairies, and Moscow is no nearer the north pole than Glasgow. Proximity to vast bodies of water causes cloud formation and cloudy conditions hinder the radiation of heat and ensure a relatively even distribution of humidity over the four seasons; drought is usually less severe or prolonged in such circumstances. In regard to wind effects, islands are not so happily placed, as the incidence of prevailing winds on the growth of trees clearly indicates. Planting is advisable in very few places in Great Britain at higher elevations than 1,500 feet above sea-level, on account of exposure, but on the mainland of Europe the upward limit of profitable tree growth may be three or four times this height, as in the Alps, Pyrenees, and elsewhere. Because of its vagaries the English climate has become a byword; it provides the forester with a continuous series of problems but, at least, it gives us the green land of Britain, as we know it, with comparative freedom from frigid winters and arid summers. Dry spells in spring, and late frosts, induced by radiation under skies made clear by the easterly winds of late spring-time, are two of the most

damaging climatic phenomena in British silviculture, other than wind-blast.

Mathematics enter into many aspects of forest management and foresters must be competent surveyors. The science of land measurement figures prominently in laying out a forest; forests must be surveyed and mapped and from time to time they must be valued. Principles of mensuration apply not only in land measurement but in calculating the rate of increment in a forest stand, from which the right time to fell in order to gain the best financial return is also ascertained. Road-making, laying railways, and building the culverts and bridges to carry them, demand engineering skill and, in this age of machinery, knowledge of mechanics is a necessity. Control of expenditure and collection of revenues are the business of accountancy and common and statute law as affecting forestry and forest workers are matters for the lawyers. Forest administration is concerned also with the laws of economics. It is impossible to ignore the implications of future trends of supply and demand in planning and carrying out forest operations, and matters of sociology, the inter-relations of forests with the life of the country-side and the welfare of the nation, also come into question from social as well as economic points of view.

The different sciences and professional lore involved in the practice of systematic forestry make a formidable list, but it is due to the discoveries of workers in the fertile fields of pure and applied science that forestry is gradually emerging from the maze of trial and error and its steps are being placed on the high-road of more certain progress. Silviculture no longer relies upon empirics. This changed outlook does not in any way belittle the wisdom and knowledge handed down by past generations of British woodmen, any more than it decries the woodcraft for which those who have followed this ancient calling have been famous. Observation of the ways of nature, on which the old-time foresters so largely relied, is still a most valuable quality in a forester's equipment; without a quick eye and a receptive brain the finger-posts of science may, even now, lead along paths that are rough and devious. A great deal of the research work which bears intimately on forestry practice is highly specialized, and is the task of workers who devote their lives to delving into the properties of natural objects; the role of forestry in these things is to apply to the best advantage the knowledge made available by others in the wide field of science.

Where natural forest exists, or artificially created woods are

3. *Japanese Larch, planted 1923, Mortimer Forest*

S. E. WILSON

4. *Neglected Larch, planted 1879, showing spindly stems and crowns whipped to tatters for want of early thinning*

maturing forestry, in the main, is a work of conservation, utilization, and regeneration. However, for a long time to come, British forestry will be chiefly creative and as the economist, John Stuart Mill, postulated, the essential prerequisites for creative work are appropriate natural objects and labour. In forestry the three primary necessities are land, tree seeds, and labour. Just any land will not do. It may be hopelessly poor ground according to farming standards, but if suitable as to situation, terrain, and soil, and in regard to the type of natural vegetation it supports, it will support crops of timber trees. The land selected must be fenced and drained and the surface prepared for planting. Where rabbits abound, as they do in most parts, it is essential that they be killed out. There is no place for the rabbit in a forest.

The second necessity is a supply of tree seeds. The forest trees commonly planted are all grown from seed, excepting poplars, which are propagated from cuttings, as are the willows also. From chestnuts and acorns down to the tiny seeds of alder and birch—it takes between eight and nine hundred thousand birch seeds to weigh a pound—all are easy to gather even if, in some cases, the season of harvest is a short one. Owing in part to the effect of injuries caused by frosts, drought, and insect pests, during the flowering season, forest trees do not bear crops of seed regularly. Oak and beech are particularly uncertain croppers, and failure may be general all over the country in some years. The difficulty is, however, more often local than general and, taking one year with another, all the seeds of native trees that are wanted, and those of certain of the important introduced species, can be collected from home sources. Conifers bear their seed in the cones. Some species ripen their cones and shed the seeds in autumn—Douglas fir is an example—others require the winter to mature the cones and the warmth of spring to loosen the cone-scales to release the seed. Pine, larch, and spruce are all in the latter class. Silver firs and cedars distribute their seed by an entire break-up of the cones while still on the branches, both seeds and cone-scales falling away, leaving nothing on the tree but the hard central core of the cone.

Tree seeds can, on occasion, be sown direct into the forest, but they are usually sown in carefully prepared nurseries where, by cultivation and transplanting, the resulting seedlings are brought up 'in the way they should go'. The importance of good nursery work cannot be overstated. For some years past over 100 million

young forest trees of various species have been raised annually in the State, trade, and private estate nurseries in Great Britain, and the signs are that this large out-turn will have to be increased. When they are three or four years old, and sometimes earlier, the young trees, or 'transplants' as they are called after having been transplanted in the nursery to induce compact growth above and below ground, are moved out into the forest where they are planted in regular rows, strips, or groups. Trees are planted at regular spacings close enough to give early control of weeds and side branches. At any time after the twelfth year or so, it may become necessary to begin thinning out to ensure that the best trees have growing space and access to light. In making thinnings, the canopy, or leafy roof of the plantation, should not be opened up unevenly or troubles may ensue with wind. Neglect to thin has been a cardinal fault in British forestry, and it cannot be too clearly realized that no plantation can be expected to develop properly unless it is thinned with judgement and at the proper times.

Forestry is protective as well as creative and guards its charges closely against all manner of hazards. Special measures are planned, and taken, to prevent or relieve ills and dangers although, with insect pests and diseases, it is not always possible to find practical remedies. A clean, healthy forest is the best protection against many forms of disease. Little that is effective can be done with some insect infestations, but others of these plagues can be trapped, as, for instance, pine beetle and weevil. Fortunately not all the insects and fungi are permanently damaging, and the activities of fewer still are fatal. Attacking in combination, however, two or more of these scourges can be devastating, and trees weakened by repeated defoliations are apt more readily to succumb to fungus disease. Vigilance is the remedy for trespass by animals and the human kind and, to safeguard forests from the hazard of fire, watch and ward must be unremitting; of all the risks and dangers to which forests are liable, fire is the most dangerous and the most widely destructive.

The management of a forest is, or should be, controlled by a written plan called a *forest working plan*, which also safeguards continuity of policy within the forest. The working plan is looked upon by the forester in charge as his professional bible. It forms a complete history of the area, and a guide for future operations, and in it are recorded the extent, physical characteristics, and intended utilization of the land; the treatment prescribed and the species to

be planted; the operations to be performed; and the precautions to be taken against risks and dangers. Periodic revision renders a working plan flexible, each instalment recording a chapter in the life of the forest. Needless to say, those who design plans of this sort must know their forestry as well as their forests and trees.

Different kinds of trees have physical likes and dislikes, often in marked degree. Some, like ash and beech, have a predilection for lime. These are the *calcicole* species, while others, the *calcifuges*, such as Spanish chestnut and Douglas fir, shun an excess of lime in the soil and do not flourish on limestone and chalk formations that are not overlaid by a depth of relatively lime-free soil. Other trees, oak is an example, are more or less indifferent provided they have moisture and a sufficient depth of mineral soil to grow in; several of the conifers flourish on acid, peaty soils which few broad-leaved trees will tolerate. Some species require more moisture than others but all require light, although a number of them, notably beech and spruce, will put up with heavy overhead shade when young. Susceptibility to the influence of smoke and fumes is an important idiosyncrasy of certain trees in a crowded, industrial country like Great Britain. Broad-leaved trees are more or less smoke-hardy, but few of the cone-bearers grow to advantage in conditions of atmospheric impurity.

Good silviculture and sound forest administration are the foundations of forestry, but they do not constitute the whole of the story. National forestry is dependent upon national forest policy, and the keynote of successful forest policy is continuity of purpose. Steady pursuit of an uninterrupted policy is the only sure means of bringing the forester's work to fruition. The long-term implications are inescapable, and when forestry is subjected to uncertainty and vacillation, whether technical, financial, or political, plans are certain to go awry. Measured in years the movement of nature in a forest is slow, and after all, the most any one generation of foresters can do represents no more than an episode in its ever renewing life. It is this inevitable deferment of final achievement which tends to instil something of the visionary into the minds of those who plan the work in woods and forests. Only thus can a forester see an ultimate panorama of the plantings he cannot hope to behold in the grandeur of full growth and abundant yield. Forest policy, single-minded in its zeal for the common good, ought always to be maintained on a plane apart from political controversy.

Notwithstanding localized intensity of effort, forestry is an extensive business in all senses of the word. Forests cover large areas and are widely distributed, and the basic principles of systematic forestry are the same all over the world. The direction of the diverse services and duties of organized forest work entails an administrative outlook embracing complete technical and financial control; the management of trained personnel and a large body of labour; the housing and permanent settlement of forest workers, and the regulation of timber supply, marketing, and the utilization of forest products. Research and experiment are also included in the scheme of direction, with education and advisory services, publications and the maintenance of public relations. In an old and thickly populated country like Great Britain complications have to be faced that are not encountered in the same degree in more recently settled lands, or even in those European States in which forest policy is not a new idea. Changes in the utilization of land, even of land not previously put to useful purpose, divergent views regarding public and private amenity, and adjustments, however slight, in locally accepted social and economic custom, all give rise to jealousies and alarms, as changes, especially changes of which the implications are imperfectly understood, usually do. Complexities of land tenure and the numerous laws concerning property in land also present thorny problems. In its present phase British forestry has many especial duties and must, by example, precept, and the encouragement of access to forests, do all that can be done to reawaken a true sense of the part forests and forestry should take in national life, and the well-being and prosperity of the country-side. In this the Federal Forest Service in the United States of America has been particularly successful during the past two or three decades, by persistent missionary work in town and country, by teaching that forests enrich and safeguard, by storing up a living reserve of an essential raw material, and by creating work and permanent homes for workers in attractive rural surroundings.

What forestry is can be summed up in a few words. It is the ancient craft of the woodman employed in close collaboration with the sciences; it is a working partnership between common sense and what T. H. Huxley defined as 'organized common sense'. It is the art of growing trees and of managing and protecting the forests in which they grow. Attempts to invest any of the operations of practical silviculture with an aura of esoteric mystery do a

disservice to forestry. There is nothing more recondite in a forester's day to day work, or in the administration of forests, than in the farmer's business of producing and disposing of farm crops. The same applies in the higher plane of forest research, in which the work does not differ, essentially, from research in other directions. The objects of forest policy in Great Britain are to recondition her cruelly exploited woods and to afforest enough new ground to assure a home-grown timber supply, sufficient to tide over wars which may yet come and to afford raw material to sustain our industries and on which to base new ones. It is our good fortune that the task can be carried out to the lasting benefit of the nation at large, without detracting from potential production in other directions. A land utilization policy is always incomplete where forests and forestry are not allowed to play a part.

Chapter 4

LAND FOR NEW FORESTS

They are ill discoverers that think there is no land.

FRANCIS BACON

In a country once so extensively forested there can scarcely be a shortage of land for the planting of new forests. In addition to the 3 million acres or so of woodland of one sort or another, there are, in fact, over 16 million acres of rough grazings and waste in Great Britain from which to select land suited to the profitable growth of trees; by far the greater part of this large area has never yet been put to its fullest productive use. Naturally, a forest policy must fit in with other desirable forms of land utilization and with the extent of land available and, in our present straits for forests and reserves of forest products, it is fortunate that there is space enough for afforestation and for all other competing interests into the bargain. The careful analysis of the land position made by the Acland Committee in 1918 indicated that the planting of 9 million acres, advocated by the Royal Commission on Coast Erosion and Afforestation nine years earlier was too much to be attempted. They found, after rigidly excluding all lands capable of being retained permanently under agriculture and a further 2 million acres of borderline tillage land, that between 4 and 5 million acres of Britain were fitted for silvicultural purposes. Of this acreage the planting of 1,770,000 acres was recommended, the work to be spread over eighty years. This was then believed to be enough to provide timber for use in any emergency which might arise in years to come. As the position appeared to be at the time, and if a long period of peace had ensued, these conclusions were reasonable, but a second world-wide war and further sacrifices of home-grown timber have upset all former calculations and have made two things clear 'beyond a peradventure': one, that the extent of the afforestations proposed will not now suffice and two, that the work of planting must be accelerated. To decide, from all points of view, upon the areas which should rightly be utilized for forestry involves considerations of general land policy; hitherto our only effective policy in regard to land has been one of *laissez faire*, and this in spite of schemes to rationalize the use of land in town and country. Since the Acland Report was published, independent estimates confirm that at least $4\frac{1}{2}$ million acres of British soil, now bare

except for heather, rough grasses, and fern, are suitable for tree planting; in these circumstances it should not be impossible to allocate enough land to forestry to assure a sufficient provision of timber for national safety and incidentally to settle a large number of forest workers and their families permanently on the land. Whatever future plans may be made for the use of the land of this country, there is no doubt that a larger area than that envisaged by the Acland Committee can be devoted to the growth of timber trees and that this can be done without interfering with the production of live-stock and other commodities to any extent that is open to serious objection.

The physical attributes and silvicultural possibilities of the lands on which timber crops can be raised differ widely in Britain. The standard of *minimum* production usually accepted is 40 cubic feet of timber per acre per annum, but this figure is proving to be well below the yield from all soils except the very poorest. Large stretches of afforestable land are to be found among the mountains and hills, and on upland heath and moor, where soils are either derived direct from the underlying rocks or are boulder clays or drift deposited by the retreating ice. Most of these soils have proved to be good forest soils although many require to be mellowed and sweetened by drainage and aeration before it is safe to plant trees on them. This applies particularly to the boulder clays and *tills* of glacial origin which are widespread over the upland regions, and to the beds of peat which overlie these deposits.

Planting sites in hilly country present special problems. Elevation, aspect, and exposure come into the picture as well as the nature of the soil; although some moorlands are dry, such as the *Calluna* moors of the North Riding of Yorkshire, there is usually an excess of moisture to be drained off. In general it is seldom wise to plant much above the 1,500 feet contour but there are, of course, exceptions. At one spot in Aberdeenshire Scots pine occurs at an elevation of 2,200 feet, a height well above the remunerative limit of planting in Great Britain and probably the highest point in the British Islands at which trees grow.

Given suitable soil of sufficient depth, the predominating factor is exposure to wind. In the aggregate a very large area of exposed land is useless for forestry on account of wind-blast, and in districts where the lie of the land is unfavourable, the upward limit of profitable planting may be well below 1,000 feet above sea-level. In this matter each area must be taken on its merits.

Out-cropping rock, and the pavement characteristic of some of the limestone formations, impose limits to forestry operations, occasionally at quite low altitudes. Peat is another complication. Many upland areas and some low-lying lands are blanketed with peat, the beds varying in thickness from a mere skin to accumulations many feet in depth. Peats differ in composition and type; some are mild and fertile when drained; others are raw, fibrous, and deficient in plant nutrients. The nature of peat depends to a great extent on the kinds of plants from which it is formed; *Molinia* peats are on the whole kindly, but cotton-grass and *scirpus* peats are never easy subjects. All moorland peats are sour and remarkable for their capacity to hold water and their lack of aeration unless thoroughly drained. The trouble is to drain and oxidize them sufficiently to encourage trees to take root and prosper; it is only where peat-bogs can be drained thoroughly and the soil exposed to the air that a few species of conifers can be made to grow up into forest stands. Spruce and pine, also Japanese larch, are among the more successful species. Apart from rowan, birch, and alder, not many broad-leaved trees are able to establish themselves on pure peats.

A glance at the geological map of Great Britain shows an astonishing diversity of rock and soil, a peculiarity of geological make-up which provides soil-types differing widely in their properties and values. Of the mineral soils, those overlying the Torridonian sandstone in the north-west of Scotland, and some of the carboniferous grits of the Pennine Chain and the South Wales Coalfield, have so far proved the least satisfactory. Soils derived from igneous and metamorphic rocks are usually more productive, except that some of them incline to acidity and may even be deficient in essential mineral elements as well as lacking in humus. Limestones and shales nearly all provide excellent tree-growing soils. On the Devonian formations conditions vary. The lighter sands and loams of the Old Red Sandstones are fertile and productive, as are most of the clays, and have long had champions among foresters, but sometimes the Old Red Series produces a thin, poor soil which presents difficulties to the forester. It is therefore unwise to take all Old Red soils for granted.

The sands, loams, and clays of the Permian, Triassic, and Jurassic rocks are mostly forest fertile. The Bunter Beds of the New Red series suit both of the pines most extensively planted in Britain and will produce oak and beech of high quality, besides a number

of other trees, including Spanish chestnut. Chestnut grows to a large size on these light, pebbly soils, but unfortunately in such places its timbers are usually so affected by cup-shake as to be useless for the sawbench. Sherwood and Delamere forests, and the newly planted forest of Cannock Chase, lie mainly on New Red sandstone strata, over which late spring frosts are even more troublesome than they are on the windblown sand of maritime origin which covers so much of western Norfolk and Suffolk. Frosty soils inevitably cause hindrances and disappointments if the species planted are at all frost-tender in their early years, so there is every reason to be wary in choosing the species for these sites. Oolites yield good planting ground apart from the heavier upland clays, and fertile forest soils occur over Cretaceous formations. The ancient forest of Anderida once covered the Weald of Sussex and Kent, and Wealden clays are still celebrated for their oaks. Beech flourishes in woods, shelter-belts, and clumps, throughout the Chalk downs and Wolds and, although the technique of starting beech to grow on thin soils over the chalk seems to have been almost forgotten, the method of establishing this species by nursing it up with Scots pine has recently come to notice again. On the deeper beds and caps of clay-with-flints, characteristic of downlands, Norway spruce grows to a large size, and in some of the folds of the downs good ash can be grown. Cretaceous greensands have a great reputation in British forestry. They probably furnish some of the best all-round soils in the kingdom for forestry purposes.

Each of these widely varying soil-types includes lands which are the despair of unsubsidized agriculture, and some require special technique of cultivation, and special skill in the choice of species, for successful afforestation. Since its reintroduction into southern Britain, the native Scots pine has re-established itself on the Bagshot and Barton sands and gravels of Eocene Age more successfully than anywhere else. It has spread far and wide through the 'pine belt' which stretches through Surrey and Hampshire as far as the Dorset Heaths, regenerating itself freely throughout this region. Corsican pine is also very much at home on lands such as these and, for what it is worth, maritime pine can also be grown in the extreme south. Many thousands of acres of the Bagshot types have hitherto yielded nothing but the roughest of grazing, and much is of such low value that it has remained unenclosed. The poorer beds of Hastings sands of East Sussex and Kent come into a similar category. All these sands and gravels produce heavy

crops of timber if properly treated; it was one of the largest areas that William the Conqueror chose for his New Forest in the eleventh century.

Reference is made in the Acland Report to the Crown Woods around Windsor and Ascot, to show what forestry can do with these agriculturally poor and neglected wastes; it is interesting to note, too, that the land mentioned was at one time subject to common rights. The Brecklands of East Anglia and light sandy lands of East Fife and the southern shores of the Moray Firth, are ideal for pine, for the growth of which low rainfall is far from being a disadvantage, lack of moisture being compensated for in the deeper sands by a reasonable degree of water conservation in the subsoil and a higher water-table than arid appearances sometimes seem to warrant. Forests are also being raised on coastal sand-dunes at Culbin and at points on the Welsh coasts, and conifers have been successfully planted on sea-sands at Holkham, on the shores of the Wash, and on the coastal dunes of Lancashire, just as the French created their great forest of the Landes on what was formerly a spreading waste of shifting sea-sand. With us, Corsican pine is the best substitute for the maritime pine used by French foresters for dune fixation, because the latter species requires more sunshine to grow to the full profit of its timber, resin, and turpentine, than the average English summer affords. Blowing sands will remain fixed under forest crops of the right trees more surely and permanently than by anything else.

Generally speaking, the presence of stones and boulders on or near the surface of the ground guarantees a certain degree of aeration in the soil. Land is not necessarily unfit for planting if it is full of stones, or if rock outcrops at frequent intervals, although such conditions may interfere with the deep ploughing now proved to be beneficial in dealing with closely packed and previously undisturbed soils. When examining new land, test holes are always a necessary safeguard: only in this way is it possible to examine the subsoil and to detect *pan*. Where pan is found between the leached surface soil and the substratum, whether iron pan or the softer moor pan, this impervious layer must be broken up. Tree roots are rarely able to penetrate pan of any sort by their own natural effort and, as farmers know, even the action of the plough can create a compacted plough-pan on stiff soils, a condition which persists and is one of the snags to look for if abandoned arable land is planted.

Such in bare outline are the principal kinds of land with which

large-scale afforestation has been occupied in Great Britain since the Forestry Act of 1919 became law, and to which British forestry must look for greater expansion. It is also necessary to remember that every possible description of soil and terrain will be encountered in the huge task of replanting the widely scattered, privately owned woodlands of Britain. Of the rocks composing the earth's crust there are few which fail to crop out in one form or another in this country; the consequence is a greater range of soil conditions than occurs anywhere else in the world within such a relatively small area as 87,500 square miles. British forestry must be equipped for and prepared to deal with all these soils, as well as with the additional complications arising from an insular climate and a natural vegetation which in many places has undergone local modification by the action of man and animals. Grazing, excessive moor-burning, and interference with natural drainage, effect surprising changes in silvicultural conditions; to avoid pitfalls, foresters must correctly interpret what they see before them and be able to assess existing circumstances properly in terms of future tree growth.

However inherently productive land may be, it will not grow any given kind of tree if meteorological conditions are not also suitable. The quantity and distribution of rain are important factors because all trees need moisture. Where heavy snowfall is a feature of the winter season, trees of stiff branching habit are liable to be broken or to be overborne by the weight of snow. Unseasonable frost checks the development of all frost-tender species, and prolonged winter frost, if severe, splits and bursts tree-bark, giving rise to blemishes in the timber and providing means of access for the spores of injurious fungi. The differences of climate from west to east and south to north, together with the great diversity of soils, render Great Britain a particularly interesting country in which to practise forestry, and make it possible for us to grow forest trees of widely different requirements. Thus, on the moister western side of the Island, trees can be planted that will not succeed so well in the drier regions of the eastern seaboard. Conversely, there are species which cannot be depended upon where rainfall is high. This is so with the Corsican pine which is likely to suffer where there is an excess of atmospheric moisture. Many exotic and some native trees grow in the south but do not succeed farther north, and where local exceptions are encountered, some unusual circumstance is always answerable. Trees so susceptible to frost as the Australian eucalypts, which only survive precariously the winters

of southern England, have been grown quite comfortably and to considerable size on the shores of Loch Hourn, a sea-loch on the western Inverness-shire coast to the north of the 57th parallel; the warm current of the Gulf Stream on its way up the west coast to Cape Wrath is the agency responsible in this case.

Foresters may be called upon to deal with land bearing no very obvious indication of its tree-growing quality. A clue may be gleaned in these cases from the wild plants growing on the ground. The inferences drawn from the composition of the natural flora and from individual species including, of course, any trees or woody growth there may be, are of very real service because plants growing wild have their own needs and preferences which, if known, disclose the nature and state of the soil including the presence or absence of important mineral constituents, besides affording evidence of acidity and the general local effects of climate. Practical farmers are aware of the value of weed plants as indicators, such as those denoting deficiencies of lime and neglect of field drains; sorrel (*Rumex acetosella*) is a well-known pointer to sour soil. But, as with most things in silviculture, experience is necessary, as well as knowledge of fact, to enable proper advantage to be taken of these guides; disaster all too easily follows blind faith in any single factor, or in a group of factors which may be incomplete. Dogmatism never pays, and to determine the possibilities of any area of land all local circumstances need to be taken into account. Bracken indicates a well aerated, deepish, naturally drained soil whether the fern grows with fine grasses or without, and bracken soils will support a broad-leaved or conifer crop according to locality and altitude. Fine mountain grasses generally occur over moderate depths of well-drained mineral soil, free from sour humus, although where mat grass (*Nardus stricta*) grows there is often a thin surface layer of peat; heather and bilberry growing among the grasses are also signs of peaty conditions. Where exposure is not too severe this sort of ground is always plantable, but, even so, nature and the mountain sheep may conspire to spread a snare. Heavy grazing of mountain grassland often effectively conceals the presence of heather, and when the check of hard grazing is removed, as it must be if trees are to be planted, the heather is apt to reassert itself strongly to give warning that a pine-spruce mixture would have been a wiser choice than pure spruce or larch. This is a rule applicable to all heather slopes and moors which should, wherever the terrain permits, be broken up by deep ploughing preparatory

to planting. Heather, bilberry, *Scirpus* or deer-grass, cotton grasses, and sphagnum mosses are all indicators of peat, and of conditions that are usually difficult to cope with except by special methods; the presence of cross-leaved heather (*Erica tetralix*) is a fairly sure sign that the ground must be stirred up, drained, and aerated before it can safely be afforested with any species. Strong growth of *Molinia caerulea* and rushes (*Juncacae*) point to milder forms of peat that are easier to manage, and healthy tussocks of the tufted *Aira* indicate comparatively free local drainage within what may be an ill-drained area.

A vast area of land of types looked upon askance by foresters twenty-five years ago has, by improved methods of cultivation and drainage, since been brought into the plantable category. Great tracts of grass moorland in the north and west, known to shepherds as white moors, can now be afforested with confidence in spite of their peaty nature. The predominating vegetation is the blue moor-grass, or flying bent (*Molinia caerulea*), often in association with rushes, heather, bilberry, and mosses. The underlying peat is seldom objectionably fibrous or more than a foot to 18 inches in depth, and, if well drained according to new methods which have been devised, spruces grow vigorously without a preliminary period of check, and Japanese larch and pine can often be relied upon to succeed. The shallow roots of spruces at once reach far out along the surface of the ground to feed on the decaying leaves of the grass, which is recognized as a most suitable medium in which to plant these useful conifers. Many upland moors of this kind were deemed unsuitable for extensive afforestation only a few years ago. Possibly the most refractory of all ground among the hills, apart from peat hags and the flows and mosses of fibrous peat, is found among the old moraines where the closely packed accumulations of glacial detritus are usually devoid of humus. Morainic knolls occur in many of the mountain valleys of Scotland and Wales and, unless the soil is thoroughly broken up, planting is not always successful. Controversy has long centred round the Scottish deer-forests, so often spoken of as a promising field for afforestation. About $3\frac{1}{2}$ million acres are devoted to the sport of deer-stalking, and parts could certainly be planted successfully by modern methods but, before more extensive acreages can be dealt with forestry technique will have to make further advances. A great proportion of this land is definitely unplantable because it lies too high and is too poor to grow profitable crops of any kind. The high corries

and rocky mountain tops to which the red-deer, by nature a woodland animal, has been banished, are windy places and over many thousands of acres soils are thin and barren, and have suffered degradation by over-grazing and repeated moor-burning.

Although there is space enough and to spare for any schemes of afforestation likely to be undertaken in Great Britain, troubles do not end with this indisputable fact. A country does not grow old and fully populated without all sorts of circumstances arising to influence the availability of its land for new purposes. Our system of land tenure is responsible for some of the difficulties. Ancient rights create impediments, statute and custom other complexities, widespread industrialization sterilizes large parts of the country and, besides the deer-forests, sporting amenities account for a good deal more. Common rights affect over 2 million acres in England and Wales. Common land is rare in Scotland, but the use of considerable areas of Highland country is restricted by Statute to occupying crofters. A right of common is a right to enjoy some part of the natural product of land belonging to another party, and it is natural that commoners should everywhere be jealous of their lawful privileges. Many commons in the vicinity of towns and villages fulfil useful purposes and are more or less fully utilized, but there are extensive common lands in the Welsh mountains, the Pennine country, and elsewhere which are by no means as productive from any point of view, as they might be. This aspect of the commons question is part of the legacy from the Enclosure Acts which, in settling the bounds of many of these open spaces, at the same time largely deprived the country folk of the means of making proper use of the rights left to them. Many of the remote upland and lowland commons are afforestable and, subject to agreement, could be leased at annual rents to the benefit of all interests concerned. Subject to a fair deal with the commoners, who would benefit also from the new employment permanently created, and due provision for public amenity, common lands that are plantable would in many cases be of more profit to the locality, and to the nation, as forest. The future of partly utilized commonable and other restricted lands forms no inconsiderable item in our problem of rational land utilization.

The principle underlying freehold tenure, handed down from feudal times, when lands were held in return for personal services to the king, is that all land is held direct from the Crown. In practice ownership is absolute and an owner of rights in land can

do what he likes with his estate provided he does not do anything to injure his neighbours' legitimate interests. This is true provided he also observes the numerous Statutes and customs affecting land-ownership, and land may also have been made subject to restraint by the owner himself or his predecessors in title, as when an estate is entailed, held in trust, mortgaged, or leased or let for the use of others. A landowner does not always retain his property solely for his personal use and occupation, and a variety of interests affecting occupation and transfer are encountered in the ordinary course of land acquisition and estate management. In addition to leases and feus, the benefits arising from ownership may be affected by rights of way, easements, and rent charges; there may also be a whole host of other considerations which help, at least temporarily, to interfere with plans for afforestation or any other new form of enterprise based on the use of land. All these matters have to be taken into account and adjusted before land can be appropriated to any fresh purpose although the late Lord Birkenhead's Settled Land Act went some way towards simplifying the position, especially by abolishing copyholds and enabling tenants for life to lease land to the State for forestry for terms up to 999 years.

In manufacturing districts the growth of trees is liable to be affected over a wide radius by the smoke and fumes from factory chimneys. Fumes emitted by certain industrial plants are deadly to vegetation, and pollution of the atmosphere, in any form, imposes a limit to the species it is possible to grow. Corsican pine, Japanese larch, and Sitka spruce, all species introduced from overseas, are the most resistant conifers in smoky localities; the common hardwoods are more tolerant of airborne impurities than the conifers, but the evidence of mature tree growth, broad-leaved or conifer, in manufacturing areas, may easily mislead, especially in woods in which the trees attained their height growth before conditions became injurious. It is quite useless to plant European larch in such places, and Scots pine, Norway spruce, and Douglas fir are unhappy if subjected to industrial smoke. Coke-ovens, foundries, and smelting works are not good forest neighbours. Surface workings for minerals affect values for forestry, and underground mining, resulting in subsidences and interferences with natural drainage, sometimes reduces the water-table over considerable areas.

Sites for new forests should be accessible because timber and other products have in due course to be transported to centres of consumption. Accessibility in relation to roads, rail, and water is

important strategically in national emergency, as in war, when large quantities of timber are required from the home woods and all means of conveyance are heavily over-taxed. It is true that wood-working industries are attracted in due course to the neighbourhood of forests, but the processed material must still be moved elsewhere to be put into use, and timber, in any form, is bulky freight to handle. Forest trees grown within a reasonable distance of markets and close to good roads and railways, command higher prices than those in the more distant forests from which heavier transport charges must be paid. New plantings in remote districts should be extensive, because only a large forest can promise a regular out-turn of merchantable timber large enough to attract manufacturers to the locality and to warrant the local installation of wood-working machinery on an economic scale. The Highlands, the Border Country, and the mountains of Wales are regions in which forest planning needs particularly wide and comprehensive vision.

The beginnings of over two hundred and fifty British forests have been planted in the past twenty-five years, and some of the new forests are already extensive. Many of the remainder are nuclei for greater forests in future, and all have been planted on land that is exceedingly low in value for any other purpose. Indeed, the capital value, in open market, of the area acquired for State planting between 1919 and 1943 averages only £2. 7*s*. per acre for the bare land.[1] Some 800,000 acres will ultimately be planted and the price of this already great forest estate which spreads, almost literally, from Land's End to John o' Groats is a plain indication of the low esteem in which typical afforestable land is held in Great Britain, land which, taken one acre with another, will produce 1½ tons of timber yearly for each acre planted. And this is a conservative estimate—some of the planted areas are already producing wood at quicker rates. Experience teaches that great forests can be raised throughout Great Britain where land values are exiguous and from whence, under economic duress, so many of the former dwellers have long since fled, leaving the ruins of farms, cottages, and crofts to bear mute witness to the depopulations. In these places silviculture will do more than assure essential timber reserves. It will draw a new population in greater numbers than before, and create, where all else has signally failed, the means of settling whole communities on these almost forsaken lands with the

[1] Report of H.M. Forestry Commissioners, (Cmd. 6447), 1943.

6. *A young Scots Pine plantation burnt out and dead, Teindland, Morayshire*

J. W. MACKAY

safeguards of constructive and healthy work and assured regular incomes. Permanent settlement on the land has been an ideal in political circles since the days of Jesse Collings and earlier, and no other system of employing rough, waste land approaches forestry in its possibilities. The land is ready and waiting, and forest workers only await the call to new homes and a life-work in our new forests.

Chapter 5

FOREST MAKING AND FOREST MENDING

Let us not be weary in well doing: for in due season we shall reap if we faint not. ST. PAUL

It is a simple job of work to plant a tree with the reasonable care necessary to ensure its growth. Indeed, setting out young trees in the forest is one of the most straightforward of silvicultural operations and, in favourable circumstances, a man can notch-plant a thousand or more transplants in a single day's labour. But artificially raised forests do not grow up mushroom fashion, or by the act of planting alone, and, after first choosing the land to be planted, step must follow step according to an orderly, pre-formulated plan of silviculture until the trees increase to timber size, and are capable of being sawn into plank and board. The first essentials in forest making are the ability to recognize, and prepare to make the most of, the silvicultural possibilities of site and soils, and to project the mind's eye into the years ahead for a view of the forest that is to be. A forester must have a defined objective as a sheet anchor; to grope a way forward, without clear conception of what it is intended to achieve, is no more calculated to lead to success than an attempt to score a bull's eye without first finding a mark at which to aim.

The first active steps are to find and acquire suitable land and to survey it in detail to determine its physical characteristics and extent and assess its silvicultural possibilities. The nature, quality, and depth of the soil are ascertained by digging test holes; and for further indications of the timber-producing potentialities, the nature of the wild herbage and any pre-existing tree growth there may be on the ground are also taken into account. Climate, elevation, and exposure also come under review at this point, including moisture and its distribution over the seasons; temperatures, and the incidence of frost; height above sea-level; and the direction of prevailing winds, and frequency and force of gales. In varying degrees all trees require moisture in the soil and atmosphere. Exposure to wind is a principal factor in fixing the upward limit of planting. Locality and altitude influence rain and snowfall, and the effects of frost and wind are closely correlated with physical geography. Most trees commonly planted in Great Britain, other than birch and the hardier pines, are susceptible to

the nip of late spring frost when young, and may be cut back repeatedly if planted where chilled air has a habit of lodging.

It is scarcely stretching the point too far to say that no local phenomenon of nature is without significance in forestry, and prospects of success rest largely on the understanding brought to bear upon the information accumulated in course of these preliminary investigations. Not only does the detail gathered together at this time dictate the species to be planted, but also the principles and methods to be employed, and the precautions to be taken for the future prosperity of the plantings. The issues at stake in the early stages of forest planning concern the whole period of the new forest's development and affect its future influence over the country-side. These are responsible issues for which the guarantees lie in silvicultural experience and judgement, based on knowledge drawn from the arts, sciences, and professions, leavened by trained powers of observation. There must also be that intangible awareness of the land and its attributes, sometimes called *land sense*, or these guarantees, strong as they are, will not be fully efficient as safeguards.

Maps and mapping are necessary adjuncts to forest surveys for the recording of boundaries and other noteworthy data. The new forest is marked out in a series of permanent, numbered *compartments* to simplify control; groups of these compartments become *working circles* and, as such, ultimately form the chief administrative subsections of the forest. Topographical planning includes systems of tracks, rides, and graded roads for access and, later on, for the removal of produce; and as part of the fire-guard scheme, *fire lines*, or *fire traces*, are laid down with due regard to the lie of the land and the direction of prevailing winds. A layout of main fence lines follows with plans for drainage and the control of watercourses. The sum of these facts and figures provides a foundation for the *forest working plan* which is built up as afforestation proceeds to stand as a permanent control for the purposes of administration. Working plans order all executive work, and tell a continuous story of policy, prescription, and achievement; the narrative being kept up to date by revisions and additions, at stated intervals, to incorporate amendments and improvements suggested in the light of experience as the years go by.

Under nature's own conditions on virgin soil forests originate by leisurely stages through long-drawn-out series of plant communities and associations, slowly merging one into the other until in

the end a climax of high forest is attained. The processes are not measurable in time and are far too slow for practical purposes. Foresters need speedier results and so resort to artificial plantings or sowings. Where there are mature *mother trees* on the ground to shed sufficient seed to produce an even crop of seedlings, regeneration may be brought about naturally and cheaply, provided the ground surface, or *forest floor*, is in a fit condition to receive the seed. This is how the vast areas of American 'second growth' forest arise, but it will not do to forget that afforestation in Great Britain has to start at scratch, on bare, untried land, and, in general, the most reliable and economical means of stocking new land with trees is to plant. Sowings of tree seeds direct into the forest have occasionally been attempted in this country and, in favourable conditions, success is quite possible with oak and other hardwoods and with some conifers. An adequate technique for direct sowing on a large scale has not yet been worked out and, on fresh ground, which has yet to acquire the properties of a forest soil, the chances of success are not encouraging. Birds and small rodents take heavy toll of the seed, and unless conditions are just right and the micro-organisms friendly to tree growth are present in the soil, seedlings have a way of fading out or, at the best, lingering for long periods before starting to grow in earnest. Often it is only as soil conditions ameliorate through the root activity of the seedlings themselves, or by the root penetrations of intrusive species, that retarded growth at last makes headway, and the delays and uncertainties inherent in attempts at direct sowing may easily lead to disappointments.

The choice of species to be planted involves momentous decisions. Luckily we have forest trees suitable for all types of afforestable land to be found in Great Britain, and the thing is to fit the different species into their right places. Conditions may be approximately the same over extensive areas or they may differ with every few acres: thus a species accommodating itself readily to one section of the forest may find another near by quite intolerable. Plantations are either made *pure*, that is with a single kind of tree, or two or more kinds can be planted as a *mixture*. Nature provides examples both of pure and mixed forest; the essentials for a successful silvicultural mixture are that the component species shall be compatible or complementary in habit of growth. Pure planting has the merit of simplifying after-management and eventual exploitation, but carries with it certain risks, notably those of epidemic

infestation or disease, as foresters in parts of Germany and elsewhere have learnt to their cost. All the same there are tracts of country over which pure plantations are the best of the practical alternatives, and extensive plantings of one species can usually be broken up effectively by groups and belts of other trees, so disposed as to help in the control of pests and to give a measure of protection from the winds of heaven and the spread of forest fire. Several different silvicultural objects can be attained by mixed planting, which may be decided upon with the idea of nursing a tender species, or for mutual protection; or to build up soil fertility; to secure intermediate returns; or with the intention of obtaining the greatest possible volume of production. If the ground is difficult, one of the trees in a mixture should possess pioneer or stabilizing qualities and, as a pioneer, Scots pine is supreme; this pine is also storm-firm. A mixture should never be embarked upon without a definite intention regarding the nature of the final crop, to which end subsequent management should faithfully be directed. It is easy to go wrong in the treatment of a strong-growing nurse such as larch. The temptation is to treat a lusty nurse species as a primary element in the crop and, in any case, hit-or-miss notions that one sort of tree may succeed where another fails is not one of the proper functions of mixed planting. Good results seldom come by chance.

Except as to certain well-recognized antipathies, individual species show surprising tolerance regarding the general conditions in which they will grow. Nevertheless, there is little profit in planting forest trees unless the surroundings are favourable, and due allowance should be made for their likes and dislikes. Oaks root deeply and grow to great size on many types of soil, provided there is depth and moisture with free drainage, and the situation is not over-exposed. Pedunculate oak ranges over the heavier soils of the lowland plains, while the natural habitat of the sessile species is more closely confined to the western and northern valleys and foot-hills, where soils are often stony, less compact, and sometimes inclined to acidity, but they must also be deepish and well drained. It is improvident to plant oak, or, for the matter of that, any slow maturing tree, except on suitable soils and in proper surroundings, if only on account of the length of time the crop must occupy the ground, a period it is not possible to justify without reasonable promise of a full yield of prime timber in the end. Land that is marginal, or sub-marginal, for oak may be quite capable of pro-

ducing two successive rotations of a faster growing species, and a vastly greater bulk of timber, in the time needed to produce a stand of prime oak. Beech-woods find their natural home on chalk and limestone; depth of soil is not important, and fine beech timber grows on shallow and relatively dry sites. Ash is far more exacting, needing a heavyish, deep, moist loam, or marl, in which more than a trace of lime is helpful. Much the same conditions suit sycamore, and both these trees are likely to produce their cleanest and best timbers if grown in company with other species. Soils producing prime oak also grow Spanish chestnut if the colder clays are excepted; light, loose soils are of little use for this tree. Tendency to develop cup-shake is the trouble with chestnut timber where the ground is not firm, a defect which has rendered many an otherwise good-looking butt useless. Poplars love deep alluvial soils, and will also grow well in a wide range of soil conditions if there is moisture in the subsoil, while the hardy birch, possibly the least difficult to please of all the broad-leaved trees, flourishes and lives out its comparatively short existence, almost everywhere. Elm, lime, hornbeam, and horse-chestnut are rarely planted extensively in the forest, while willows are not usually regarded as forest trees.

The timber-producing conifers are not, on the whole, an exacting section of the cone-bearing family, and there are not many places in which one or another of the pines, firs, or spruces cannot be made to flourish. Almost the only general limitation is exposure; soil quality is seldom a major consideration, and sands, gravels, loams, peats, and even clays may all support vigorous growth of one conifer or another, if moderately aerated and attention is given to drainage. Individual conifers vary in regard to the moisture they require, and some of them evince idiosyncrasies which it is wise to indulge. Scots pine does not resent the poorest of light and medium soils if they are not too firmly compacted, and where there is no pan to impede root penetration, nor is pine particular regarding moisture as long as drainage is free. Poor, dry, light lands suit Corsican pine. The spruces delight in humidity both in the soil and atmosphere; Norway and Sitka spruce are excellent forest trees for the valleys and hills of western Britain, and for many of the blanket peats, provided pure plantings on heather-clad moors are avoided. Spruce does not thrive in dry regions and should not be planted extensively where the average rainfall is scanty. European larch, naturally a tree of steep

mountain-sides, is more catholic in its general tastes, but is averse to sour soils and compacted and really heavy ground. Due, no doubt, to circumstances not fully understood, its behaviour is by no means consistent nowadays, especially in some of the wetter districts, even where there is a good run-off. The Japanese larch, however, seems quite at home in our regions of high rainfall in the west, flourishing under a wide range of conditions, and is much less subject to disease than its European cousin. Like the spruces, the graceful western hemlock and *Abies grandis* revel in humidity, often succeeding best when planted in moderate shade. Nearly all conifers grow to perfection on the cretaceous greensand belts. English foresters hold greensand soils in high esteem, but the thin, flinty soils over chalk are not easy subjects to plant successfully; Austrian pine is perhaps the most tolerant of the *coniferae* on subsoils of pure chalk, apart, that is, from the native yew. Larch and other species may often start away quite well on chalky soils, only to fall victim to heart rot while still in the pole stage, and Douglas fir is not a good choice where there is an appreciable proportion of free lime in the soil. On the deeper caps and beds of clay-with-flints characteristic of parts of the southern downlands it is possible to grow sound pine and spruce, but a reasonable depth of soil is essential and, for the latter species, the surface soil must be moist. Caution is always advisable within the range of industrial smoke. A polluted atmosphere is never a good forest condition; smoke is sometimes borne great distances from its source by wind, as the fleeces of mountain sheep, grazing many miles down wind, frequently testify. The grime of fumes can always be detected on the herbage of localities affected.

The mutual protection trees afford one another against the force of wind is remarkable. Massed plantations, even of shallow rooting species, withstand considerably more exposure to wind and weather than single trees or small woods. The secret is to get a plantation to close in as quickly as possible and thereafter to maintain a regular canopy. Soft, saturated places are danger spots if planted without thorough drainage, and Douglas fir, especially, cannot be relied upon to stand up to the force of wind unless the site affords good anchorage for its roots; it is never worth while to take risks on exposed wet ground with any species. Too much water in the soil is just as great an evil as too little; excesses of moisture must be got rid of, and the run-off maintained by keeping drains open.

Forest land is drained by open cuts which, in hill country, are

most effective if led gently downwards along the contours. Open drains carried straight up and down the slope do little to dry out the ground and are calculated, besides, to scour badly after heavy rain, the results being erosion and consequent losses of soil. Peats require particularly thorough drainage and aeration. In order to dry out a mountain peat, the first step is to cut a drain along its upper limit deep enough to intercept seepage from higher up. Flat peat mosses, in fact all areas of bad natural drainage, are doubtful subjects unless a clear outfall is obtainable.

In this country the cost of fencing against farm stock and wild animals can seldom be avoided. Grazing and browsing animals must be kept out of young plantations, and it is useless to plant until rabbits, the foresters' curse, have been thoroughly warrened and the area enclosed with a rabbit-proof fence. Wire-netting is the only effective fencing material against the destructive rabbit, and it is worth noting that young rabbits can get through any wider mesh than 1¼ inches. Rabbits almost always begin to scrape in the angle formed by the fence and the surface of the soil; to discourage this habit a 'flange' of 6 inches of the netting should be turned outwards on the ground at right angles, as a hindrance to burrowing. No ordinary fence will exclude hares, and fencing at least 6 feet high is required if wild deer are numerous. Live hedges and stone walls do not protect plantations very effectively; the most serviceable forest fence is one of creosoted posts with an appropriate number of wire strands plus rabbit netting.

Traces of former cultivation in preparation for planting are to be seen here and there in older woods, and local recollection confirms that ploughing and 'trenching' used to be done occasionally. It is probable that elaborate preparations of ground were not attempted on any extensive scale in former years except possibly to facilitate direct sowings of acorns, but within the past two decades ways and means of cultivation for afforestation have been receiving increasing attention and, more recently, great advances have been made in turf planting, deep ploughing, and subsoiling. At the beginning of the present revival of afforestation in Great Britain, the almost universal methods of preparation were to scrape, or *screef*, away the natural herbage in patches for the reception of the transplants, or to plant in pits. After 1919 these methods were varied, on the East Anglian Brecks and some other places, by ploughing a single or double furrow with an ordinary field plough to clear the ground surface for the young trees. The so-called

'Belgian' system of planting on turves, and Sir John Stirling Maxwell's important work on the peat bogs at Currour, have pointed the way to deal with peaty moorlands; over the last fifteen years successes with spruce and some other conifers, by planting on deeply cut, upturned turves of peat, have been consistent and striking. In the same period mechanical cultivation has also advanced. Caterpillar and other modern tractors have made the changes possible. Experiment in ploughing on difficult lands has been assiduously pursued, particularly in regard to plough construction and design; only exceptionally strongly built implements stand up to the heavy strains involved in competing with boulders and stony, compacted soils and in turning over a broad furrow-slice on ground covered with dense moorland herbage. Turfing and ploughing have combined to bring large tracts of land into practical consideration which were previously regarded as doubtful, if not useless, for afforestation; one of the advantages of deep ploughing is that it thoroughly breaks up 'pan' formations. As far as experiment has gone, complete ploughing seems to be unnecessary, a single or double furrow, traced to conform with the espacement desired, having been found, so far, to answer the purpose. Taken by and large, there is not much afforestable land in Great Britain on which some form of preliminary soil cultivation is not an advantage and an economy.

In spite of aids afforded by preparatory cultivations, young trees are always at a disadvantage when first planted out into poor, raw ground on which no traces of forest growth have survived and where conditions essential in a forest soil must gradually evolve as the plantations develop. The presence of almost any pioneer tree growth is helpful, however sparse it may be, probably because the mellowing influences of root-spread and leaf-fall cause improvement to the surface layer of the soil. Properly managed advance growth is also of use as protection from wind, sun, and frost, while coppice shoots and the stiffer types of ground vegetation including old heather, which were formerly regarded as nuisances and cleared or burnt off, are now treated less cavalierly and may often be conserved for the benefit of new plantings. There is, however, this all-important proviso: no weeds or coppice shoots of any sort can be allowed to interfere or compete unduly with the natural development of a young plantation.

Artificially raised timber trees begin life in a forest nursery. It takes three to four years to produce transplants fit for planting out,

seedling trees being rarely planted direct into the forest from the seedbeds. Any method of reducing the production period in the nursery saves time and money, but it is nearly always cheaper in the end to make use of medium-sized, sturdy stock which has remained in the nursery for three or four years and has been transplanted at least once in the meantime, rather than to attempt short cuts. Soils for nurseries should be good, the best choice being a deepish, friable loam. Clays are heavy and sticky to work, and it is difficult to maintain a sufficiency of humus in hungry, sandy soils. A great deal of opinion has been voiced concerning ground for forest tree nurseries, some maintaining that the soil should not be richer than that of the forest in which the trees are to grow, others urging that the better the nursery soil the stronger the young stock will be. As usual the extremists at both ends of the argument tend to overstate the case. Nurserymen require a well-drained, moderately fertile soil, and what is important, one which can readily be cultivated at all seasons, with an open situation that is not severely exposed, and as much freedom from frost as is possible to find.

Tree seeds are sown broadcast or in drills. Weeding is easier if seeds are drilled, otherwise there is not much to be said for or against either method. The troublesome habit of soils containing particles of clay to set, or cake, on finely tilled surfaces may constitute a serious hindrance to effective germination, and for small seeds the safest covering material is Bedfordshire silver-sand or coarse, clean, river sand. Where these materials are not readily obtainable, fine stone chippings are the best substitute. It pays to be cautious in making sowings in a new nursery. Most species, spruces in particular, should not be sown until the soil has become inoculated with the specific root organisms of the species, a condition which can be brought about by using the ground, in the first instance, for lining-out seedlings of the species in question.

Seed-beds and nursery transplant lines require thorough weeding. A dirty nursery does not produce the well-grown, well-rooted trees needed for planting out, and when the time comes to lift plants from the nursery seed-beds and lines great care is necessary or there will be damage to delicate roots and stems. Good handling is gentle handling on all occasions. After lifting, plants are graded to cull out weakly and malformed stock. Finally the small trees are tied in bundles for transport. Like the young bear in the story, a small tree has its troubles to come, and the sturdier

the transplant the better its chances of survival in forest surroundings. Inefficient nursery work prolongs the period necessary to establish plantations in a thriving condition and adds to cost. Nor is nursery work all beer and skittles. The ground has to be kept in good heart and nursery stocks succumb easily to improper treatment and to diseases, pests, and extremes of climate. Delicate seedlings need artificial protection against sun and frost; the mechanical action of frost-lift is the cause of wholesale losses; cockchafer grubs, against which the only effective remedy known is to dig the ground and hand-pick the grubs, can also be devastating; drought, frost, insects, and fungi all add their quota to the risks. To produce healthy, well-proportioned plants and to deliver them in a fit state for planting out is a specialized art in itself.

The planting season begins in late autumn. As long as mild, humid conditions prevail, trees can be planted all through the winter well into the following spring. There is something yet to be learnt regarding the best months in which to plant individual species, a matter which can only be settled by carefully recorded experiment over many seasons. The point is one which planters of holly hedges will appreciate, because to put in young hollies except in the earliest or very latest days of the normal planting season is to court failure. It is advisable to suspend planting operations in severe weather, and the work ought to be stopped entirely during hard frost, or in periods of persistent, dry wind accompanied by clear skies. A spade is the favourite tool, and numerous suitable patterns are in common use; a mattock is handy on steep hill-sides, while the dibble is sometimes employed for very small plants. The method generally adopted is the 'L' notch, and, if the work is skilfully carried out with the right type of plant, results are usually excellent. Planting on turves may be done with a circular spade, or the plants can be inserted into a vertical slit cut in the side of the turf. Most forest trees survive the shock of final planting out satisfactorily if elementary precautions are observed and care is taken to dispose the roots naturally in the soil and firm them well in; more than half the battle is to grow good nursery stock and never, at any stage, to allow the roots to become dry.

The townsman is often puzzled to know why foresters plant their trees so closely together, putting in from 1,700 to over 2,000 trees per acre when they only need a final crop of between 100 and 200 large trees by the end of the rotation. The statement that experience has shown that this is the best way of doing the job is

not very illuminating although quite correct. The truth is that there are several good reasons for the practice.

In the first place, foresters plant closely in order to shade the ground quickly and so kill out the surface weeds and vegetation; secondly, they want to grow clean boled, straight trees, and this can only be done by planting the trees closely enough to cut off the light from the lower branches and cause them to become suppressed and eventually die. Thirdly, trees are like human beings in that some are strong and straight growing, while others are stunted or crippled. In order to get even 100 well-shaped vigorous final crop trees, many times that number must be planted, and inferior individuals gradually thinned out as they outlive their usefulness.

A further point is that some trees such as oak have to be crowded in youth to induce vigorous upward growth; if planted far apart they tend to become low branched and short in the bole. Lastly, the united front which a well and closely stocked young plantation opposes to the wind is a great advantage in exposed situations. The outer rows of the trees take the brunt of the blast, enabling the trees inside the plantation to grow up tall and straight.

Such, then, are some of the reasons why a forester indulges in the apparently wasteful procedure of planting many more trees on a given area of ground than he can hope to harvest when the crop is mature.

The distance apart at which trees are set out varies according to species, soil, and situation. It is usual to plant in rows, $4\frac{1}{2}$ feet being regarded as a standard espacement for trees with moderately persistent side branches. Closer spacing is advisable with slow-moving species, but rapid growers such as Douglas fir and Japanese larch are planted up to 6 feet apart or more. Wide spacing has a considerable bearing on economy: at 6 feet spacing 1,210 transplants cover an acre of ground but, if the planting distance is reduced to 4 feet, the number of trees rises to 2,772 per acre, an increase of almost 125 per cent. in number and corresponding costs. Latitude in this matter depends upon species and growing conditions, and the species which can properly be planted at wide espacements are limited in number.

With every possible precaution full stocking does not always follow as a result of the first planting. In spite of experience and skill, small trees will die now and then, and when the number and distribution of the failures warrant it, blank spaces in a plantation must be made good. Replacing the small, dead trees is termed *beating-up*

the plantation. To preserve mathematical precision of pattern is not so much the point as to take care that the area shall be reasonably free from gaps; replacements need not be tree for tree in all cases, and beating-up should aim rather at leaving no reasonable growing space unoccupied. It is important that there should be no undue delay or the trees originally planted may gain so great a start as to make it impossible for the late comers to compete for space and light. On occasion it may be helpful to beat up with a different species, and beech is often spoken of as a good tree for filling blanks; but beech has an annoying trick of refusing to grow to order when planted as a beat-up and if it does grow normally of becoming decidedly troublesome in the after-management of the plantation, so its virtues for this purpose have perhaps been overestimated. Fast-growing conifers answer the purpose better as a rule, but the principles to be observed in introducing another kind of tree as a beat-up are broadly those applying to the formation of mixed forest. If in any doubt, it is always wise to keep the planting pure.

Grasses, fern, and other wild growths require to be kept in check where they threaten to interfere. No rule of thumb can be stated for weeding new plantations, and to weed or not to weed is often a nice question: what is certain is that plantations are easily ruined for want of timely attention to weeds and that young trees must be kept free from excessive competition. All conifers require weeding until they are well away from the herbaceous weeds and under-growth, and broad-leaved species require light and air to ripen each successive year's growth. Close inspection and quick action are essential in forest weeding, also judgement, for money can be wasted by unnecessary weeding. At a later stage plantations are *cleaned* of intrusive growths and, as the trees close in and the real struggle begins for a place in the canopy, systematic thinnings follow in due course. Pruning of selected stems may also be desirable but, in this connexion, economic aspects should be closely watched.

The business of repairing the enormous devastation of British woodlands during the past thirty years poses a series of problems similar, in most respects, to those of afforesting new land, but there are some fundamental differences. In old woodland, where soils are already conditioned by root-penetration and leaf-fall, qualities have developed which are particularly acceptable to tree growth. While this is true of most woods in which the soil has been protected by a forest canopy, it is less true of soils in open woods and coppices where the forest floor has been incompletely sheltered or

periodically laid bare. A mature forest soil is a most valuable silvicultural asset and one that is quickly dissipated if the area is left exposed to wind and weather with nothing to protect and conserve its humose character. Replanting should, therefore, proceed with all possible speed on sites that are clean and unprotected; the urgency is less where there is still a soil cover, in fact where underwood will grow on to useful purpose it is often best to leave it to do so. Useless coppice growth must be dealt with sooner or later and complications from severe root competition and strong growing stool-shoots arise in replanting this class of woodland; where each layer of the soil is full of active root systems, young transplants have to battle for survival among these strongly established competitors.

The early treatment of cut-over woodlands cannot be systematized too closely. Areas can be classified within limits and many are true to type, others differ to such an extent that many individual woods will require special prescription to make sure that the most economical method of reafforestation is adopted. Sites of former conifer crops are likely to be infested with beetles and weevils, pests which prey eagerly on newly planted trees. In these conditions there is nothing to be done except to wait until the insects have exhausted all breeding and feeding places in the old stumps and rubbish, a wait which may mean delay up to three years or more before a coniferous species can be replaced with safety. For economy in time and cost all natural advantages should be turned to account. Two obvious aids may be available and it is wasteful to neglect either of them. The first is natural regeneration, for seedlings of utilizable species will make an appearance in varying profusion in numbers of woods, even if zeal for war-time timber production has outrun silvicultural discretion to a lamentable extent, and few mother trees have been left to re-seed the exploited areas. Complete natural restocking will be rare, but every useful tree so raised represents one less to be planted artificially. The second aid to reafforestation lies in the correct employment of healthy underwood and coppice. Stool-shoots can be grown on for conversion to high forest or encouraged for a period with a view to future thinning and use as shelter wood for under-planting, and all moderately well-stocked chestnut coppice is worth mending and preserving for short-rotation cropping. Circumstances will compel acceptance of minor forest species as well as more valuable trees; it will not do to despise birch, aspen, lime, and others which will form at least a temporary crop to cover

and conserve the soil and yield some profit. Birches have few foes when young, not even the omnipresent rabbit, and they can be relied upon to come up freely in many of the old woodlands.

The state in which our ill-used woods remain after exploitation will be a source of concern and expense. Many areas left in a tangle of lop, top, and weeds after the 1914–1918 fellings were not replanted on this account, and modern war-time methods have not noticeably improved. Litter, properly used, can be helpful as a protection to mast and seeds against wood-pigeons, and seedlings from other foes. However, to reap the benefit of this protection and properly to tend and fill up the new crop, the delay in re-establishing cleanly forest conditions must everywhere be short. Felling and hauling operations are apt also to pay scant respect to gates, fences, drains, and forest rides, matters which represent no mean item in the cost of woodland repair.

Success in the great national work of forest repair depends on the goodwill and unreserved co-operation of a variety of interests, and on the availability of silvicultural experience and skill and an orderly administration, but all these things will be of no avail without sustained policy. As the lawyers say, time is of the essence of the contract, and speed in this case means more than mere haste to replant. Planning and organization to meet the schemes formulated are obvious necessities; more foresters must be trained, and young trees of the species best calculated to replace the lost reserves of timber with the least lapse of time will have to be provided in continuous supply. Some of the faster growing conifers like Japanese larch, Sitka spruce, Douglas fir, and Corsican pine will be invaluable, nor should the possibilities of Black Italian poplar be overlooked as a rapid producer of wood. To the same end the most complete degree of stocking attainable is to be desired if the nation is to benefit to the utmost extent from the potential productivity of the ground, although conditions of soil and shelter will be found which justify rather wider espacements than are permissible on bare, new ground. Larger plants, too, are often an advantage among heavy undergrowth. There will be no lack of room for the native hard-woods, oak and beech, or, in suitable places, for ash and sycamore.

Woodland owners have one inescapable duty, namely the total elimination of the rabbit. If British foresters were freed from this expensive incubus, natural regeneration would frequently become a factor to rely upon, and all cost of rabbit fencing and warrening,

with which our silviculture is taxed, would be saved. The full sum of this impost over the coming years of woodland reparation will constitute a substantial and entirely wasteful drain on the funds to be expended. Other pests to bear in mind are honey fungus and heart rot. Damage by honey fungus is inevitable when conifers are introduced into old hardwood areas; of the softwood trees, Douglas fir shows the greatest resistance to its attack.

The efficiency with which weedings and cleanings are carried out will mark the difference between success and failure in many places. In spite of the cost it is better to cut weeds, and slash down unwanted coppice shoots to ground level, in the first years of a new planting: with coppice harsh treatment pays in the long run. Unless smothered by weed growth, healthy natural regeneration can look after itself up to a point, and oak saplings, however thickly they come up, are usually best if left to themselves until they have grown well into the thicket stage; with other species massed thickets may require attention earlier to prevent the development of drawn-up stems too weak and whippy to sustain their own weight later on. Valuable patches of young ash and sycamore, often slashed about and broken in course of timber felling and hauling, will shoot again and grow into shapely trees, if the damaged stems are neatly coppiced at the collar with a sharp bill-hook in early spring, before the new buds burst.

In all directions reafforestation will be carried out in the high hope that tall woods will spring up once more, a hope which will materialize only if we are single-minded in our effort and the work is guided by experience. Much labour and much money must now be devoted to the task. Where there is indifference or clash of interest there will be waste, and where other than silvicultural considerations intrude, final results must always be in doubt. Especially in the first years, nothing can be permitted to stand in the way of essential weedings and cleanings at the proper seasons, and thinning must never again be neglected as in the past. So great an expenditure of national energy and of private and public funds is only warranted if there is clear comprehension of the long-term implications of forestry enterprise. Never before has national forestry, in any part of the world, been faced with labours equal in vital urgency to those now confronting British foresters in this country, and what has been called 'the high cost of second best' will not suffice to restore the woods that we have lost.

7. *One of Britain's New Forests, Rendlesham, Suffolk*

FORESTS AND PERPETUAL PROFIT

The rules of the game are what we call the laws of Nature. T. H. HUXLEY

THE description of forests as the one source of primary production capable of perpetual self-renewal by the forces of nature comes very close to the truth, but, as exploiters of timber lands soon find out, it is only the forests in which natural regenerative powers are directed according to the dictates of good forestry from which profit can be made to accrue uninterruptedly. In the practice of the silvicultural arts, a forester's endeavour is to keep the growing space at his disposal fully stocked with healthy timber trees and to maintain regular incremental growth from which to draw a uniform periodic out-turn of wood and other products. In other words, the object is to maintain a continuous flow of raw material which can be translated into terms of money income.

Increment, in forestry, is the volume of new wood laid on seasonally by the trees of all sorts, ages, and sizes by which the forest is populated; the chief aims of systematically conducted forest operations are to manage so that the timber-producing capacity of the soil is employed to the full, and increment and out-turn made to balance without encroachment upon the volume of the growing stock. The proposition is reduced to its simplest proportions in woods which are planted, allowed to grow up, and ultimately clear felled. The time between planting and felling may extend over a great many years, with high forest it can seldom be otherwise, and in the meantime no substantial profits are obtainable, in tangible form, other than those afforded by intermediate thinnings. The crop is harvested at one swoop, after the manner of a field crop, with the important difference that seed-time and harvest in the forest are a lifetime, or longer, apart. Although sound forestry is, of course, based on an ever recurring series of regenerations and fellings, the laying bare of large sections of a wood, or forest, at a single felling defeats some of its fundamental objects, which are at all times to keep a reserve of growing timber in hand, to maintain increment, and to safeguard regularity of supply to the dependent wood-working industries. An essential condition of successful marketing is that outlets for forest produce shall not alternately be starved and flooded at uncertain intervals; the market for home-

8. *A Forest Tree Nursery*

grown timbers has suffered enough from intermittent supply in past years.

The one way to make certain of maintaining a maximum standard of production is to keep every quarter of the forest constantly and properly stocked with trees, permitting no gaps in the stands, or in the distribution of the graduated age classes, and to fix the amount of timber cut and removed according to the year by year growth of the standing trees. In a well-managed forest stocked with the right species to a proper degree of density this gives the exact measure of the timber-producing qualities of the soil.

The first objective is to build up the sequence of *age classes*, ranging from seedlings, or newly set out transplants, to timber trees ripe for the axe, so that each age class is distributed about the forest in an aggregate acreage equal to that of each of the other age classes. This arrangement lays the basis for a cycle of periodic fellings and replantings wherein the most advanced age-class areas are cut and, by replanting, become automatically relegated to the youngest, and so on. Under correct management there is no limit to rotational progression in this way, but until trees of all ages, from those in the youngest age class upwards, are spread evenly through the forest in point of area, successive fellings, whether arranged yearly or at longer intervals, cannot be planned with regularity either as to volume or area. Without control by age classes the rhythm of production is bound to be subject to disturbances, and the only sure means of securing a uniform rate of revenue is to preserve an even flow of age-class succession. It amounts to this: where age-class groups of equal aggregate acreage are maintained in graduated series and the timber periodically cut, including the volume of thinnings and improvement fellings, is no more than has been laid on by the trees since the previous *coupe* was made, then there is no reason, short of disaster by storm, fire, pests, or bad management, why corresponding rates of production and out-turn cannot continue indefinitely, and the stocking of the forest remain for ever unimpaired. This is the basis of the theory of *Sustained Yield*, a fundamental principle of systematized forest management in all parts of the world.

Several reasons render it advisable to disperse stands in each individual age class over the whole extent of the forest, rather than to segregate even-aged plantations in single blocks as may be permissible, even inevitable, in the smaller woods. Age-class distribution reduces risks to the crop, making it possible to work a number

of *felling series* simultaneously and so to avoid concentrated fellings and laying bare a broad expanse of forest land on any occasion. Felling series are arranged within working circles, as a rule, and each may include more than one *cutting face*. New cutting faces are opened out by *severance fellings*, which should be orientated with due regard to prevailing winds and other hazards. Adjustment of a graduated age-class series is a matter of time when dealing with neglected, or over-exploited, forest and with new afforestations. It is not always possible to make the rate of planting conform to the two governing factors of total area and the time needed to complete the anticipated rotation. Urgency to plant may be imperative, as it is in Great Britain to-day, and where yearly planting programmes vary from the area fraction imposed by the term of the rotation, it is impossible to create all the steps in the age-class scale within the limit ordained for the first rotational cycle, nor can a new forest be brought to the point of greatest sustained profit in the time. The special conditions in which new afforestation work is undertaken call for no inconsiderable exercise of patience before age class is made to succeed age class in regular order; time and silvicultural skill alone endow newly created forests with the attributes of perpetuity. Speed and hustle are of no avail, and shaping the form of the new forests now being raised in this country is not work for a man in a hurry, young or old.

Opportunities to study these aspects of forest management are few and far between in Great Britain, thanks to the pusillanimity of former generations in matters of systematic forestry. Evidence of continuous policy is not easy to find in our older woodlands, and the new national forests, planted since 1919, are still too young to illustrate more than the earliest beginnings of the principles involved. Something can be seen here and there where the production of timber has been the main object in view. Possibly the most simple picture of this aspect is now to be seen in the chestnut coppices of Kent and Sussex, where coppice stands are managed on short rotation for material for the cleft-pale fencing trade. To take the case of a Kentish chestnut coppice, 60 acres in extent, worked on a twelve years rotation: the area cut over annually is 5 acres, and the gradation of single-year age classes falls naturally into twelve steps, beginning with the 5 acres of first year's stool shoots on the area cut in the previous season and proceeding to the similar acreage of twelve years' growth ready for exploitation in the ensuing winter. Supposing the value of the material in the yearly 5-acre

cut to be £30 per acre (it may be more or less), then the gross sum realized for the year is £150, or an average of £2. 10*s*. for each acre of the entire wood, an annual gross income per acre that is maintainable, subject to the prices current for this kind of coppice, as long as the wood is properly looked after, and managed so that annual fellings are restricted to the rotational fraction of one-twelfth of its 60 acres.

Sustained yield from woodland presupposes two elementary conditions:

1. Continuity of forest policy.
2. The practice of good silviculture.

These essentials assume that the capital investment in the enterprise, that is the land with its permanent improvements and the growing trees, will be safeguarded and maintained, and that volume production and exploitation will be consistently equated. No emphasis can exaggerate the necessity for continuity in long-term policy in regard to a crop so slow to mature as timber; technical skill is, in its turn, equally important. The history of forestry abounds with instances of the folly and improvidence of attempts to work to any but a planned objective, and of failure to pursue sound policy with resolute will. Each separate operation in forestry is undertaken in preparation for the next ahead; if a rung is missing from the ladder of achievement something is sure to go awry.

It is as vital to conserve fertility in a forest soil as for a farmer to keep his agricultural land in good heart. The valuable silvicultural properties developed in soils densely covered by trees merit equal care to that bestowed on any other asset of value. Ideal soil conditions for forest trees cannot be conjured up overnight on neglected or newly afforested ground, and conversion of a degraded, or raw, soil to a fertile woodland mould comes about slowly. The dying out of ground vegetation, due to the closing in of overhead canopy and the exclusion of light, the gradual formation of a humus layer from the annual fall of leaves and twigs, aeration by root penetration, and the stabilization of water content, are all ameliorating influences affecting the texture and permeability of forest soils. These things also encourage biological and chemical activities to assist the processes of breaking down vegetable and mineral matter to create, or free, nutrients for absorption by tree roots. The enrichments brought about by years of forest growth and biochemical action, however, are not permanent and deteriorate rapidly through the abrading effects of wind and weather where ground surfaces are

exposed by felling; in hilly country erosion soon begins to take a hand when the soil cover is removed. Humus, and often much of the soil itself, is frequently lost if felled areas are not replanted within reasonable time, and broad clearings aggravate all sorts of risks and dangers as well as soil impoverishment. Soil that has been mulched and tempered by years of tree growth is a capital item of great worth in silviculture, but its fertility is quickly dissipated by mismanagement.

The construction of forest capital is complex. Growing trees are the most conspicuous item; each available acre of the forest should carry as many stems as the rules of good forestry permit if there is to be no waste of growing space. Idle land represents so much unproductive capital; blanks and gaps in a wood are wasted ground except in so far as room is needed for roads and rides, stacking grounds and other sites. The capital investment includes all improvement works of permanent value. In most forests, particularly those situated in remote and undeveloped districts, access and exploitation roads, inspection tracks, bridges and culverts, fire lines, reservoirs for water supply for fire-fighting, embankments, drains, and fences are all necessaries involving the expenditure of capital moneys. Provision has also to be made for housing forest workers in sparsely inhabited districts. Finally, there is an element on which it is difficult to put a price but which is none the less of account to the credit side of the forest's equipment. This is the accumulated value of experience gained in course of continuous local management, often a very material contribution to the successful cultivation of a forest.

Foresters clear their first hurdles as their young plantings become established. However, there are plenty of obstacles ahead, and what a forest crop requires at all stages is understanding and sympathetic treatment. Forest trees need help and guidance towards proper development without attempt to force a pace beyond which nature will willingly go; to try for more is one of the certain roads to disaster. When, with the aid of judicious weeding, a plantation has overcome the competition of herbaceous and coppice weeds, intruders such as honeysuckle, briar, thorn, birch, and sallow are cut out in the process known as cleaning. This is done to prevent the injury unwanted species can do by overcrowding and suppression, and by whipping tender leading shoots. The harm done to young trees by the strangling tendrils of honeysuckle alone must be seen to be believed. After cleaning the crop soon closes in and begins

to form canopy, and as the lower side-branches die for want of light, they are removed by *brashing*, a stem-cleaning operation undertaken to facilitate inspection. Brashing also serves to prevent the formation of knots and pin-holes in the wood, and is a valuable counter-measure against forest fire besides encouraging the free circulation of air within the plantation and helping to promote healthy growth. The lower branches of larch and densely grown broad-leaved trees die off fairly quickly, and when dead and brittle can be knocked off to the desired height with a stick. The side branches of other trees, especially spruces, remain tough and resistant a long time after death and must often be cut off. For this work, bill-hooks and other edged tools should not be used except by the most experienced workers under close supervision. Edged tools require expert handling in a forest, as elsewhere, if mishaps are to be avoided, and a well set hand-saw is the safest tool in most hands. The material removed by brashing should be cleared away from the verges of rides, where risks of fire are intensified; elsewhere within the plantation, twigs and branches can be left lying to rot down and enrich the soil. Money can sometimes be saved by brashing alternate rows; at this time suppressed and malformed trees are best left untouched for removal in the course of the first thinning.

In the next phases of a plantation's life the density of the young stand is reduced by successive thinnings designed to afford growing space and light to each individual tree that is left to grow on. Two of the cardinal rules of good forestry are that timber trees shall stand close enough together to induce them to grow tall, straight, and clean stemmed, and at the same time that they shall be kept thinned out sufficiently to give each tree the room it needs to develop, particularly as to crown space and the leafage necessary to play its due part in nutrition. Judgement and a nice balance are needed to bring these requirements into conformity. Height, form, girth, and the width of the annual rings are all controllable by thinning, subject to soil quality and exposure, and the frequency and regularity with which a plantation is opened out. Promising plantations soon go wrong if there are delays and if the trees to be cut out are not properly selected. The result of failure to attend to silvicultural thinnings is a crowded, drawn-up stand with short, tufted crowns bearing scarcely enough foliage to keep alive trees which tend also to develop into weak, whippy poles lacking substance to support their own weight. Under-thinned woods lead to

sadly inadequate crops and have done much to strengthen the cry that forestry does not pay.

Manipulation of forests for the greatest benefit of mankind depends on method and watchfulness in carrying out the unending cycle of silvicultural work according to the knowledge vouchsafed to foresters from one generation to another. It is important, therefore, to place proved facts and improved methods on record for the information of those who follow on, and to publish the results of experience for all to know and apply, as may be fitting, to local conditions. There are many things yet to be discovered and worked out, but the fund of experience never ceases to grow, and if ascertained facts regarding the behaviour of different species, in the varied conditions in which they are planted in British soils, are not committed to paper in detailed form, many a valuable hint is lost and must await rediscovery.

Theorists find thinning a fruitful subject. In point of fact the marking of plantations for the purpose is just one more of the common-sense forestry operations. The first things to bear in mind are the habit of growth of the species and the rate at which the plantation is growing together with its situation and the risks to which it is liable. Secondly, there is the question of the types of timber it is desired to produce. And remember that thinning history is faithfully recorded within the trees as the years go by. It may be read from the widths of the annual rings, regular in well-grown timber and displaying considerable variation in badly tended stands. Sins of commission are to be avoided as well as of omission; not the least of the considerations is to leave the wood evenly spaced after a thinning both to preserve the canopy and to provide for an ultimate selection of as many trees as possible to stand for the final crop. At the first thinning the dead, suppressed, and malformed trees, and any coarse-growing *wolf trees*, are removed. Where gaps resulting from the cutting out of wolves are likely to be large enough to trap an eddy of wind and start a windblow, or to expose neighbouring trees to the risk of being overborne by snow, offending trees of species that are not hosts to bark beetles can be ring-barked at the proper season and left to die. However, it is not to be forgotten that every strong-growing tree in a plantation is not necessarily a wolf. The term can be interpreted much too liberally.

Fast-growing conifers reach the stage of first thinning after fifteen to twenty years. Each separate plantation must be treated

according to its needs, and Japanese larch has occasionally been found to require treatment as early as the tenth year. The common broad-leaved trees are not so precocious and seldom demand attention until after twenty or more years of growth, although the opposite-budded ash and sycamore may require pruning well before this as a counter-measure to forking. With healthy young plantations, thinning policy resembles the prescription for feeding a horse: i.e. 'little and often'.

Light demanding species, larch and ash especially, quickly go wrong if overcrowded. Partial shade-bearers are more complaisant to begin with, but crown expansion must be allowed for as they grow into the pole stage, the penalty for misjudgement being an unmanageable stand of long, bare poles with insufficient substance and insecure root anchorage; wariness in regard to root-hold is especially needful in the case of Douglas fir. If plantations are kept under close observation after they have been cleaned and brashed the chance of a major error in subsequent tending is greatly reduced.

Thinning treatment due to sensitive light-demanders may leave a wood with a light, or open, canopy giving insufficient shade to protect the forest floor and to suppress bramble and other weeds. A wood of this description is also lightly stocked as to volume and prospective final yield. To remedy this state of affairs, underplanting is occasionally resorted to, and beech, hemlock, *Abies grandis*, Douglas fir, and the spruces can be planted under the shade of open plantations, as an undercrop to supplement yield or to afford a more satisfactory soil covering. By no means everything has yet been learnt about the management of underplanting in British woodlands, and the operation is not one to be undertaken unless the future course of events is clearly in view. Tending two-storied high forest is a complicated business which often induces premature removal of the original crop if the trees underneath are to have the chance to grow into timber of reasonable size and quality. But when the under-story is designed primarily as a means of cleaning up the over-crop, or simply to afford soil protection, this difficulty scarcely arises.

Clean stems for purposes such as telegraph and other poles, and wood free from knots for veneering and plywood, are obtained by getting rid, by pruning, of unwanted side branches as they become suppressed, if they are too persistent to be removed by any less expensive means. Expenditure on artificial prunings of conifers is warranted only if special markets are in view; to prune whole

stands up to a height of 20 feet or more is out of the question for several reasons of which the most cogent is cost. Where pruning is economically advantageous, the best plan is to select up to a hundred per acre of the best and straightest trees, taking care that they are evenly spaced throughout the wood and so unlikely to complicate subsequent markings for thinning. Suppressed larch branches can generally be knocked or raked off to the desired height but evergreen conifers must be hand-pruned. The purpose of pruning is served best if the branches are cut off before stems exceed 4 to 5 inches in diameter, so as to leave as small a knotty core as possible, and, as with the earlier work of brashing, much damage may result if pruning is not done neatly and cleanly. Exposures of, and injury to, the *cambium* do not always heal easily and they provide lodging-places for the spores of wood-destroying fungi; pruned branches should be cut off flush with the stem, without stripping the bark, and no protruding snags should be left to hinder occlusion. It is not always possible to go high enough in a single operation; usually the work is confined to the removal of dead and dying branches, but the foliage of some conifers persists, even in dense shade, and it is then permissible to prune away the lower whorls of green branches provided care is taken not to reduce unduly the proportion of the living crown. A hand-saw and a light ladder are the best tools. Young broad-leaved trees growing in close canopy are self-pruning to a greater degree than conifers. Double leaders and occasional persistent snags are sources of trouble with the common species. Poplars are an exception; clean poplar timber cannot be grown without progressive attention to pruning. While growing vigorously, poplars should be kept closely pruned, including green branches and all secondary epicormics, up to two-fifths of their total height until a satisfactory length of clean bole is secured. Good management produces forest-grown timbers of qualities suitable for all ordinary uses, the additional refinement of pruning is only justifiable in anticipation of special utilization. Within limitation and in the right circumstances it is worth while, but, in general, pruning holds out no prospect of proving economic if done indiscriminately or on a large scale.

Forestry aims at growing descriptions of timbers the locality is best fitted to produce. The intention may be to turn out pitwood, pulp-wood, poles, saw logs, or butts for peeling into veneers, or any combination of the many different kinds of major and minor

produce of commercial value, but, whatever the intention, the continued safety and welfare of the forest are paramount considerations. Growing stocks must be maintained and felling and regeneration arranged in ordered rotation: a simple rule, perhaps, but not always simple to carry out, because nature cannot be taken for granted and man is a greedy animal when markets are good. Natural and economic forces destroy as well as create. Overcutting is not justifiable except in extreme urgency, and if such an emergency should arise, or if exceptional damage is suffered from gales, fire, or other possible causes, the remedy lies in adjustment of the periodic coupes over the rest of the forest until a balance of increment and out-turn is restored over the whole area. Clear felling is not in all circumstances the most thrifty method of taking the final crop. The silvicultural ideal in restocking cut-over areas is to regenerate by natural seeding, and to this end a mature stand may be cleared in a series of *regeneration fellings*, to permit the ground to become effectively restocked by means of natural seed shedding; re-seeding by leaving a limited number of trees to stand as mother trees is a well recognized way of restocking a felled area. Species yielding seed freely and with moderate regularity, oak or pine for instance, regenerate successfully by these adaptations of nature's method, but not every kind of tree responds. Forestry that ignores the possibilities of natural regeneration is wasteful of its own potentialities.

A forest is never at any period free from dangers and must be guarded unremittingly from threatening hazards of climate, pests, trespass, and fire. In a general way, planning, organization, careful tending, and attention to forest hygiene are the safeguards; effective protection from seasonal risks and dangers, which are the forester's daily fare, calls for forethought and technical skill in very high degree. Of the creatures that run wild in the woods fortunately not all are harmful. Wild birds, especially, are busy destroyers of the insect horde, and birds, insectivores in particular, should be encouraged in all woods by every possible means. Forest protection is one of the foremost branches of silvicultural work, and British forestry must needs keep its eyes wide open, its drains scoured, and its fences taut, in the fight to keep our woodlands healthy and prosperous.

Sustained yield and regular income are synonymous terms in forestry. To arrive at net income, the day by day costs of management, labour, and material, and of the current ancillary services,

are deducted from the gross revenue derived from forest produce plus all other sources of profit. But a full account goes deeper still, because a bald statement of material debits and credits excludes much which comes from the mere fact of forest ownership. There are gains to individuals and the nation at large that are beyond the narrow limits of price accounting. Industry, employment, and other economic and sociological advantages and amenities, and, most of all, an assurance of national security, help to make up the *summum bonum* to a forest-owning people. The balance sheet of a nation's forest policy should be weighted accordingly on the credit side.

Economics may be a 'dismal science', but its teachings apply throughout the business of forestry. Good silviculture does not prosper if its financial implications are ignored. Foresters, like all other cultivators of the land, live out of the soil and therefore must earn a surplus to keep them in health and strength; spending must be balanced against reasonable expectation, so that it is futile to dwell among the tree-tops and not come down to the mundane aspects of forest management. It is also useless to grow trees as a crop unless due attention is paid to methods of marketing and utilization. New and wider markets do not fall like manna from heaven; they have to be sought and organized persistently. Price values in many parts of the world have too often been related to costs of exploitation and transport, with the intrinsic value of forests and their products coming into calculation as a bad second. On the other hand, no one with any knowledge of finance expects a long-term investment to bear a high rate of interest. In forestry money is invested with the certain knowledge that it cannot fructify until many decades have passed. In this the compensating consideration is that wealth accumulates in the meantime and is being stored up within the forest. The first concern of foresters is to foster the resources entrusted to them and in due course to hand on their forests, not only unimpaired, but improved in value and productive capacity. Nationally, we have the broader duty of giving consistent support to a firm forest policy, without the aid of which the most earnest endeavours of the forester are brought to nought. Good silviculture, and adherence to the principles of sustained yield, offer a national investment needing no sinking fund.

Chapter 7

WHAT FORESTS PRODUCE

The well-being of a people is like a tree: its roots are in the land, manufacture and commerce are its branches and its life; if the root is injured the leaves fall, the branches break away and the tree dies.
FROM THE CHINESE

MATERIALS derived from trees have had enormous influence on the development of the human race. From the earliest ages until the present time the wood, bark, juices (resins), leaves, and fruits of trees have been sought after for the aid and comfort they afford to mankind, the enlightenments of modern existence rendering us more, rather than less, dependent upon things that are to be obtained only from forest trees. The chief produce of the forest is wood, and wood is one of the indispensable primary products on which the bases of civilization are founded. It is used in its natural state, or laminated, compressed, impregnated, or otherwise processed; in the form of wood pulp or wood flour; and is a principal source of the carbohydrates which chemistry and the inventor turn to account in an ever-increasing multiplicity of ways. And, apart from timbers, forests yield an abundance of products and raw materials necessary to sustain standards of living to which we have become accustomed. The beginnings of many far-reaching discoveries can be traced to ideas inspired by the forms in which trees grow and the properties of their woods, for, in spite of primitive claustrophobias, our remote forebears looked to the 'forest primeval' for nourishment and means of shelter and defence. Who can doubt that the forerunners of familiar types of tools and weapons were branches torn from trees and roughly fashioned, or that the buoyancy of a floating log bore with it the first conceptions of a raft and sea-going ship? The prototype of the wheel was certainly the rolling stem of a tree, and the mind to realize the power of leverage inherent in a pole, harnessed for mankind one of the greatest of all natural forces.

No other product of the soil can be applied to so many diverse purposes as wood. Its services extend from fuel to ladies' French heels and from newsprint to toothpicks. Sawn into scantling and boards or otherwise converted, the wood of forest trees can be adapted to any form of construction or manufacture from bridge-building to silks and sugar. In the pole length it provides masts and spars, telegraph and transmission poles, shores and struts, and

is convertible by cross-cutting into pit-props and mining timbers. Plywood, now so universally in use where strength and lightness are required, is made from veneers; in fact, no limit has been set to the diversity of purpose to which timber can be put. Pulp of wood, reduced by mechanical grinding or chemical disintegration, gives us paper, fabricated board, and cellulose, the last-named being a basis of very many industrial products including viscose and rayon silks, artificial wools, and nitro-cellulose explosives. Charcoal, alcohol, acetates, and wood tars are obtained by dry distillation, and by more recently invented processes wood is also turned into molasses and animal feeding-stuffs. In the realm of plastics further fields are opened for the utilization of wood derivatives, including lignin, the limits of which cannot be foretold.

The woods required in industry are preponderantly those of the cone-bearing trees. Softwoods have advantages over hardwoods in lightness of weight and length of fibre, and are esteemed for their adaptability and the ease with which they can be worked. No crop of comparable utility produces a greater quantity of raw material per acre on a poor soil than a forest crop. The principal timbers of commercial interest grow just as successfully in Great Britain as in other regions of the north temperate forest belt; indeed, most of the pines and spruces grow more rapidly in Great Britain than they do on the mainland of Europe. The British climate has much to do with this, as might be expected, but the quality of the woods these trees produce in our forests naturally relates closely to the qualities of our silviculture and forest management.

Although falling far below wood in quantity and value, some of what are known as *minor forest products* are of great importance in manufactures and commerce. The discourses of Evelyn and the older writers on trees are crowded with references to the properties of various parts of trees, which were made to yield oils, dye and tanning stuffs, fodder, distillates, and infusions, and to the simples and sovereign remedies for all manner of ills which were brewed, extracted, and compounded from them. Many of these former domestic uses for trees, their barks, and leaves, have been superseded, or, like numbers of the homoeopathic remedies, simply forgotten.

Foreign trade supplies modern substitutes, often cheaper if not always superior, for many articles formerly obtained from local sources. The depreciation of our oak and hazel coppice woods is due to nothing else but the failure of their products to compete

with cheap imported turnery, barrel-hoops, tan-bark, and charcoal, and, unhappily for the nation's bread, even country bakers no longer fire their ovens with faggot wood. It is the same story in nearly all rural industries founded on the produce of woodlands —other than sawmilling. During the twenty years prior to 1939 even the home timber trade found it hard work to keep its head above water. But, while skill lingers, as it does in many country districts, there is hope that some of the old crafts may survive to benefit the country-side. Among hopeful signs, nurserymen's demands for seeds of the principal forest trees, including those of introduced species which yield crops of seed in this country, are showing signs of expansion to correspond with the course of forest policy at home and abroad.

Under the restrictions imposed by the grip of war, it has been surprising to discover how extensive the resources of our estate woodlands really were. British woodlands, which were subjected to reckless exploitation between 1914 and 1939, have for a further five years and more of war been able to supply other products as well as saw-timber and pitwood, in unprecedented quantity. Ancient forest arts and crafts have revived, and it is food for thought and future enterprise that, with organization and attention to markets, the more commercially attractive of these half-forgotten rural trades could continue in the post-war years, when it will be a duty to make the most of home resources and means of affording employment.

One of the reasons why so many things can be done with wood is that the timbers of different species of forest trees vary so greatly in composition and structure. No two kinds of wood are exactly alike in their physical and chemical properties. Timbers are either soft and easy to work, as those of most conifers, or tough and resistant to saw and plane, like many of the hardwoods. Wood is durable or perishable, smooth in texture or coarse-grained, pliable and resilient, as ash and wych elm, or stiff and unyielding like oak. The terms 'hardwoods' and 'softwoods' speak for themselves, and woods are heavy or light, tough or brittle, and absorptive or resistant to impregnation. Colour also varies from the dead white of horse-chestnut wood and the so-called white-woods of the spruces and silver firs, through a range of yellows, reds, and browns, down to the blacks of some of the tropical timbers such as ebony. The two great classes into which woods are broadly divided in common parlance, exhibit remarkable differences in cellular formation, a highly important consideration where length of fibre is concerned.

In this the conifers score heavily over broad-leaved species, and the longer-fibred softwoods are consequently much more extensively used for pulping.

More than 9 cubic feet out of every 10 of the timbers of all kinds used in British industry are produced by cone-bearing trees, and 98 per cent. of the total quantity of the softwoods we consume is grown in other countries. The folly of dependence on foreign supply to such an overwhelming extent is clear when it is realized that up to 40 per cent. of the wood imported could conveniently be grown at home. The indigenous Scots pine produces home-grown timber equal in utility to any shipped from the Baltic as the red and yellow deals, so largely in demand for building construction, carpentry, and railway sleepers. Railway sleepers alone are imported by the million and have cost us up to £2 millions each year. They are cut chiefly from Scots pine timber, which possesses the right strength, resiliency, and creosote-absorbing qualities for the purpose, that is from material which could be grown, sawn, and creosoted at home. The heart-wood of Corsican pine is of a paler colour than that of Scots pine and, although a very useful timber, little of it reaches the home markets from abroad and its quality is not yet widely known among consumers, nor is forest-grown timber of this species yet available in quantity from British woods. Another of the reddish softwoods in which this country could be self-supporting is larch. For Douglas fir, American red cedar, and others we have hitherto been obliged to rely upon Canadian and United States forests.

Larch has long been held in high repute for its strength and durability. It is inclined to twist, warp, and check or split in seasoning, but is valued as baulks and piles for bridges and harbour works, transmission poles, and boat building, and, because of its lasting qualities, it has long been regarded as the home-grown timber, *par excellence*, for estate repairs; it is also highly prized as mining timber. For general utilization, however, larch has failed to hold its pride of place and, furthermore, being a light-demander, it produces a small volume of timber per acre by comparison with the pines, spruces, and Douglas fir which are thus cheaper to grow as well as being more amenable to manipulation in the workshops. Douglas fir, a most useful timber, now in the forefront commercially, is used for most purposes for which softwoods are employed, although its cellular structure is such that it does not absorb preservatives readily. Red cedar (*Thuja plicata*) yields

first-class timber for building wooden houses, an art that has been neglected in all but a few localities in Great Britain; this tree also provides cleft shingles for roofing which, when exposed to the weather, take on a most attractive silvery patina. The wood of Lawson's cypress also has many uses and, being especially resistant to acids, is employed to make separators for electricity storage batteries. All these trees flourish in British conditions.

Prodigious quantities of conifer pit-props and timber are used in mining. A lion's share is consumed in the collieries, but wooden props, bars, and lagging are necessary also for winning haematite iron and china clay. Pit-props are poles cut into lengths to correspond with the widths of the coal seams and are classified by length and top diameter. Props of nearly two hundred different sizes are asked for in the various coalfields; lengths vary from a foot to 13 feet and top diameters from 2 inches to 12 inches and over. It goes without saying that in normal times nearly all this material has been imported. It has come to us from the spruce and pine forests of the Baltic region, the maritime pine forests of the Landes and Portugal, and for the balance of our supplies we have relied chiefly upon Canada and Newfoundland. Home supply is small except in time of war. What is so ridiculous is that, although thinnings from growing plantations yield just the type of raw material required for pitwood, one of the principal reasons why silvicultural thinning has been so consistently neglected in British forestry has been the lack of a profitable market for the thinnings.

The wood-pulp shipped to our ports is manufactured almost entirely from conifer wood—largely from poles of kinds which should be taken out of our plantations by way of thinnings. Imports were on the increase before the first of the world wars and the cost per ton was rising even more rapidly. The average yearly imports into Great Britain for the years 1909–13 were 860,000 tons valued at £4 millions. By 1936–8 the average quantity had risen to 2 million tons costing £12·7 millions in cash. Prices are more likely to rise still further than to abate, and henceforward we shall certainly not be able to do without still larger supplies of the pulp of wood; new uses are constantly being found for it, and possibilities arising out of chemical and pressure treatments are not yet by any means exhausted. So much is this the case that British forest enterprise can never hope wholly to supplant foreign supply, but, with sufficient areas of new afforestation, sited in the right places, there will be plenty of wood in years not so far ahead, together

9. *Glen Garry Spruces*

with water and potential hydro-electric power, to make the beginnings of a home wood-pulping industry. In this, as with other major items of forest produce, there is the prospect that our dependence upon overseas forests may in time be partially shaken off.

The debt of civilization to the pines and firs is not commonly recognized. The great bulk of the world trade in timber is in the woods obtained from the conifers and it would be uncomfortable, indeed, to forgo the products these useful trees supply. Conifers grow relatively quickly; their timbers are easy to handle and are readily adaptable to the requirements of modern life. To be of full service the trees must be well and evenly grown and free from knots and blemishes—all of which amounts to no more than the practice of good silviculture and systematic forest management.

The timbers of broad-leaved trees, known as the hardwoods, are not consumed in such vast quantities as those of the softwoods, but no other materials serve so satisfactorily for the particular requirements they fulfil. Apart from timbers such as mahogany and teak, obtainable only from countries in the tropic zone, all but very few of the hardwoods dealt in by timber importers in quantity are either indigenous to, or have long been acclimatized in, Great Britain. Even so, production from the home woods has only amounted to an insignificant percentage of the broad-leaved timbers used in British wood-working trades. Oak, ash, beech, birch, and even elm have been imported in considerable quantity, while, in too many of our woodlands and hedgerows, trees of the self-same species have been allowed to stand to become over-mature, rotten, and worthless for utilization. Forestry of this kind is sheer waste—a wood full of aged, decrepit, maimed, and decaying trees is a useless and melancholy prospect, if only as a reminder of the mutability of all living things. The moral in this is that timber trees should be harvested when they are ripe after the manner of any other crop, and the land replanted.

The durability of British oak is a byword. The timbers of our native oaks, pedunculate and sessile, are unequalled by oak timbers from any other part of the world, if properly grown. For one reason and another (none of them very far to seek) there is a great deal of ill-grown oak standing in the English woods, trees of inferior quality, cross-grained and knotty, the timber of which is not easy to utilize. Often the best trees have previously been taken out; in other cases the soil or, it may be, the situation is unsuitable, or the silviculture has been at fault. But it is well within the capacity

10. *Telegraph Poles in New Forest*

of British forestry to produce clean, mild-working oak if soil and locality are wisely chosen; the principal reason why oak timber has been imported to so great an extent is that the foreign material is graded as to quality and mild to work. With our oak woods properly sited and managed there would be no need to go abroad for oak plank and manufactured goods, or for cooperage, for, sad to relate, most of Britain's justly celebrated beers are now stored in barrels made of oak staves of foreign origin, even of oak from Japan.

After the battle of Trafalgar, numbers of public-minded people, fearing for ship-building supplies, planted oak trees in all manner of places and soils. Some of the oaks planted in the Forest of Dean at this time, in parts of the forest where the soil is too brashy to produce good oak, are no more than 8 or 10 inches in diameter after a hundred and twenty years of growth, and the story is the same in other woods about the country. But it is only fair to say that many of the trees planted in the post-Napoleonic period have developed into sound timber of good dimensions, a great quantity of which has proved of service to the nation in the wars of the present century. Even in war-time, however, the demand for the poorer stands has been on a restricted scale. Turkey oak (*Quercus cerris*) has become established in a number of woods, where it regenerates freely from seed; unfortunately it is almost useless as a timber tree.

The wood of our native ash is noted for its toughness and pliability. Prime home-grown ash is now scarce, because heavy demands for material for aeroplane manufacture and games appliances have robbed the English woods of the best of their young ash trees, and not much timber of high grade now remains. Ash of our own and other species is imported for use in the furniture, motor body, and agricultural implement trades, also as tool handles, purposes for which the lower qualities of home-grown wood could serve equally well if made available in organized supply.

Beech is of even greater economic importance, but again, only a small part of the quantity consumed comes from British woodlands. The beech tree grows relatively quickly for a hardwood, and although there may not be room in this country for beech forests on the continental scale, enough could be grown to provide greater, and, what is so important in marketing home-grown woods, more regular supplies than hitherto. The quality of properly grown English beech is not in question, but only clean-stemmed timber of

the right dimensions can compete with the imported article. There is an assured place in our future forest policy for beech; among other things it is, above all other hardwoods, the best for use in substitution for softwoods in time of need, besides being an excellent plywood timber.

The fourth of the British hardwood trees of major importance is elm. In spite of an abundance of elm in the hedgerows of the midland and southern counties, elm timber is brought in from America and Japan by importing concerns. Whatever the origin of our common elms, other than the truly native wych elm, home timber-merchants recognize three kinds—the English, Dutch, and Wych elms. Well sawn and expertly stacked and seasoned, elm timber is a most useful wood, it is remarkably durable under water, while straight-grained wych elm approaches ash in some of its characteristics, although heavier and coarser. The price obtained by growers of home-produced elm has frequently been a paltry one, and, after one of the periodic south-westerly gales has left more than the usual number of windfalls in its track, elm has proved actually unsaleable in some districts. In spite of plenty, the itch to import has gone to the length of bringing in foreign woods for making tin-plate boxes, for which purpose home-grown elm was so long the standard material.

Poplar, sycamore, sweet chestnut, and birch all produce serviceable timbers. Poplar wood is light and does not readily splinter; it is in demand for veneering and match manufacture, but requires special skill in sawing on account of its woolly fibre, which tends to clog the saw. At present rates of utilization, the timbers of sycamore and the rest of the common hardwoods could be supplied from home sources with comparatively little effort; the problem is the double one of producing the right sort of log and of organized marketing. Walnut wood, used in the furniture trade and for panelling, gun stocks, turnery, and veneers, comes mainly from Central and Eastern Europe and the United States; all the *Juglans* are frost tender and not at all easy to establish in forest conditions in our climate, nor has their silvicultural treatment been fully worked out in this country.

The birch timber used in British industry comes in the log, or in a manufactured state, chiefly from Canada and Northern Europe. Birch ranks as our oldest-established indigenous forest tree. It is common in most parts of the country and is very hardy, but because it has never been properly cultivated, home-grown birch is not of much account. With the increasing use of plywood,

it may be that more attention will be given to ways and means of growing birch properly, to produce the clean, cylindrical boles, free from fluting and fleck, that are required.

Expansion in the use of plywood has given a fillip to the trade in clean-grown timber for cross-cutting into bolts for peeling into veneers. While the discovery is not new that three or more thin sheets of wood, if glued together with the grain crossed, possess resistance and toughness out of all proportion to the strength of the component sheets, the process has undergone such great developments in recent years that the manufacture of plywood is now one of the most important methods of utilizing forest-grown trees. Poplar, beech, birch, sycamore, alder, and some of the conifers, as larch and Corsican pine, make first-class veneers for plywood manufacture. In the years before the second world war, Great Britain paid the foreigner as much as £6 millions for veneers and plywood in a single year, besides importing logs for the home-established peeling plants. During the war additional peeling machinery has been installed, and one of the tasks which our forestry must face is that of growing trees to satisfy this assured future demand.

Coal, and coal derivatives, have almost universally taken the place of wood as fuel in British households. In the majority of houses the demand for fuel logs is small, and the price often extravagant owing to high costs of transport. Wood logs are more freely used in country districts, and to build up a really good wood fire an old-fashioned open hearth is needed. Most of the hardwoods make good fuel, especially ash, oak, and beech, which burn well and give out great heat; the exceptions are poplar and elm, although both will burn if they are really dry. Apple-wood is celebrated as a fuel-wood in west-country homes and windfalls from the orchards seldom go begging. The resinous pine and fir logs burn brightly but rapidly and are apt to throw out sparks to the detriment of rugs and carpets. As kindling wood, waste soft-woods, and birch twigs which are made up into bundles in great quantities, are largely used. The chimney sweep should be employed regularly where wood fuel is burnt because wood smoke carries off inflammable tars which tend to accumulate in chimneys and are not infrequently the cause of fires. It is probable that many a fine old country house has been destroyed in this way, although there need be no risk if regular attention is given to the sweeping of chimneys.

Folk-lore has spread an aura of romance around the ancient forest craft of charcoal burning. The manufacture of charcoal by the time-honoured open kiln method is almost, but not quite, extinct in British woodlands. A few of the old-style burners are still to be found in Kent and Sussex, in Wyre Forest, and along the Welsh Marches, but the portable steel kilns which have now come into use are both cheaper and more speedy to operate. Charcoal is also one of the products of wood distillation. About 10,000 tons of wood charcoal, representing between 40,000 and 50,000 tons of cordwood, are consumed annually by the steel, chemical, rayon, and other trades—war-time demands are heavier. In pre-war times almost the whole of the quantity was obtained from abroad, mostly from Belgium and France but, in part, from as far afield as Rangoon. The modern steel kilns are sectional and conveniently portable; burning can be regulated to a nicety, and there is no insuperable reason why this rural industry should not be retained permanently in the home woods. Once again it is a question of organization and marketing. The raw material for charcoal is the corded branch-wood of felled trees, the wood used is principally hardwood, oak and beech being the best kinds. Birch also yields a good charcoal, and a specially fine quality is made from the wood of alder buckthorn (*Rhamnus frangula*), a shrub, found in damp woods throughout the country as far north as the south of Scotland. Alder buckthorn wood was formerly imported, but since 1939 many hundreds of tons of this material have been found and cut in the English woods, rather to the astonishment of consumers; the bark and fruits also yield a medicinal extract akin to the cascara extract obtained from the Persian buckthorn. In this instance, as in others, the full resources of our native woodlands have been insufficiently realized in many quarters. Charcoals derived from softwoods have different properties and are not so heavily in demand. Before the outbreak of war in 1939 the price of high grade, clean charcoal varied from £5 to £6 per ton, but during the war the price has more than doubled. It is satisfactory to note that home production has been able to cope with all demands.

Tapping for resins and turpentine in conifer forests is not likely to become a profitable business in this country. A continental summer climate is required to induce a sufficient flow, and the maritime pine, an important source of European supply, is not happy far away from parts of the south coast of England; very

large forests are necessary to sustain a trade in these commodities. Vegetable dye-stuffs, obtainable from such native trees as dog-wood, alder, and birch, have been supplanted by aniline and other chemical dyes, while the market for tan-bark has been virtually killed by products richer in tannins such as valonia and quebracho, both products of forests abroad. During the past forty years the prices offered for oak bark by the tanneries have not been attractive, although there is no sole leather to beat that formerly produced by the old materials and processes. Progress and change there must be, and new and cheaper ways of doing things take the place of older methods; nevertheless, in times of stress we have been glad of the minor products of our woodlands and their derivatives, and some of them have still got possibilities to which practical attention should be devoted.

Trade in forest tree seeds is internationally extensive and well organized. Our export trade is small, but all the seed of native species that is required is harvested at home. Of the introduced conifers, the most widely planted species all give indication that they will bear seed freely in British forests; unfortunately, most are yet too young to produce the quantities required. Seed of Sitka spruce, Douglas fir, and others comes from Canada and the United States; Japanese larch and Corsican pine are obtained chiefly from their countries of origin, and Norway spruce from Central Europe. Seed of the common larch also comes from Central European forests, but care is necessary in selecting the region from which it is obtained, because seed from certain districts is preferable in British conditions while that from others is almost useless; some good seed comes from Silesia. Our best and most healthy larches are grown from home-produced seed, and the European-Japanese hybrid, raised from seed saved from British plantations of these trees, standing in juxtaposition to each other, is a noteworthy addition to the species available for use in afforestation. All the seed of Scots pine required is collected at home, and the native race and sub-races are better suited to British soils than any of the strains from the mainland of Europe.

To harvest conifer seed, cones are picked from the trees at various times in the autumn and winter seasons, according to species; some kinds ripen and shed their seed earlier than others. Pine, larch, and spruce cones are not thoroughly ripe until the end of the year, and after they are gathered must be stored in a

dry place until the seed can be extracted, an operation which ought not to be unduly delayed. To secure the seed the cones are subjected to moderate heat in specially constructed kilns, to open the cone-scales and release the winged seeds, which are shaken out, winnowed and cleaned, and stored in air-tight containers, in a cool place, until required for sowing. A bushel of good, plump, Scots pine cones yields 10 to 12 ounces of seed and there are approximately 75,000 seeds to the lb. As with all other crops there are good seasons and bad, and conifers do not cone freely every year; spruces, which were conspicuously prolific throughout the country in 1942, failed to produce cones in nearly every locality in the following year. It therefore becomes necessary, on occasion, to keep seed for more than one season and, fortunately, seeds of most of the important conifers retain their viability for several seasons if properly stored. Douglas firs often cone profusely. They shed their seed early in autumn and there is no time to be lost if the crop is to be saved; but there is also another risk. Douglas fir seed is subject to attack, while still in the cone, by a dipterous insect (*Megastigmus*), which destroys the germ. Cones of the silver firs must also be gathered early in the autumn, because the cone-scales break away from the central stalk of their own accord as soon as they ripen, and are scattered with the seeds by the four winds.

The seeds of the common hardwoods are not difficult to secure, taking one season with another, although satisfactory masts are local and intermittent, and abundant supplies of acorns and beech mast do not occur every year, moreover beech seed is frequently light and unfertile. The state of the weather at flowering time is largely responsible for the variability of the crop, and leaf-rolling insects destroy oak blossom as well as young foliage in bad 'caterpillar years'. Acorns and beech nuts are gathered from beneath the trees and stored thinly spread over dry floors or in sacks; sweet chestnuts are treated in the same way as acorns. Sycamore and ash seed profusely, in fact, there is only one record of a general failure of the ash in the last thirty years and none of sycamore. Alder, birch, and most of the lesser species also seed regularly and in abundance. Ash seed, only a small percentage of which germinates in the first year, is stored, or *stratified*, in pits with damp sand until the second spring and then sown. Other broad-leaved seeds of precarious viability or those which cannot be relied upon to sprout in the first season, particularly fleshy fruits such as hawthorn, are treated in the same way. Stratification for a short period prior to

sowing is also advantageous in the case of some conifer seeds, notably Douglas fir.

It is a fundamental principle that seed should not be collected from trees with qualities of form and growth that are inherently bad. In practice, however, it is easy to make selection more rigid than circumstances warrant. With the form of individual trees much depends on soil, situation and silviculture, and a long-lived organism, like a tree, does not, except by way of a 'sport', change its inherited characteristics in a single generation. Nor is it possible permanently to influence character in one rotation. Wheats, mangel wurzels, or any other quickly maturing plant can be changed out of all knowledge by selection and plant-breeding in a decade or less, but to effect corresponding changes in the habits of trees would take the better part of a thousand years of patient work. Seedlings from acorns from a spreading, park-grown oak do not reproduce their parents' form when grown in forest canopy, and the chief things to look for in a mother tree are health, vigour, and form, without coarseness. Artificial maiming can no more affect the suitability of trees, otherwise of good type, as parents than it does in the case of animals; the risk of perpetuating coarse growth or tendency to disease is quite another matter and is never worth while.

The English coppice woods present difficult problems. It must be admitted that their heyday has passed, coppices of Spanish chestnut being the one exception. The coppices of hazel, oak, and ash formerly fitted themselves admirably into the rural scheme, but demands for coppice produce no longer justify the retention of large areas under this form of silviculture, and for the most part we can write 'Ichabod' over the once carefully tended coppices of the country-side. Half a century ago no part of the coppice crop was wasted, and the skill with which the old-time woodmen made up the periodic cut was a marvel of efficiency and neatness. The craft lingers here and there but the uses made of the stool-shoots have, one by one, been superseded. Poles, turnery-wood, charcoal, bark, wattle hurdles, barrel-hoops, crate wood, stakes, spar-gads for thatching, and faggots constituted a regular out-turn which, to-day, is reduced to a mere tithe of what it used to be. Stakes and poles for fencing, and pea and bean sticks are among the items now produced, and a few hurdles are still woven. The result is that a widespread and helpful rural industry has almost faded away. The coppiced oak of the West of England, the Welsh valleys,

and the West of Scotland, no longer cut in rotation for bark and fuel, has grown on during years of neglect to store up a valuable reserve of hardwood pit-props; this source of supply might well have been drawn upon even more extensively to make good war-time scarcity of softwood props.

Many thousands of young spruce are wanted every year for Christmas trees. Holly and mistletoe find a ready sale at Christmastide and florists take evergreen and ornamental foliage and mosses at all seasons, sphagnum moss being also collected for use as surgical dressings. Truffles are not uncommon in the beech-woods, and edible fungi of other kinds grow in the woods, where much wild food, esteemed in other countries, goes to waste. Game and the skins of animals help to swell the forest revenues, indeed, almost everything a forest produces can be turned to account. There is, however, one product which no forester, worthy of the name, will ever dispose of and that is the leaf-mould of the forest floor from which the soil derives so much of its fertility.

The sawdust pile, produced in the conversion of timber, remains an embarrassment to all concerned. Many attempts have been made, and much ingenuity expended, to find economic uses for this by-product; in the meantime the problem of getting rid of sawdust is almost as difficult to solve as that of its profitable utilization. There are sawdust heaps dating from the 1914–18 war still lying in the woods.

Chapter 8

WAR AND THE WOODS

Qui desiderat pacem, praeparet bellum. VEGETIUS

THE clash of arms is the antithesis of the serene tranquillity of the woodland wild, and yet no war has ever been waged without aid from the forest. It was so in the days when battles were won with sticks and stones, and since then the indispensability of wood has shown itself in the campaigns of every successive age up to the present era of steel and concrete, in which timber still retains its importance as one of the principal munitions of war. Military forces depend upon the equipment and munitions with which they are supplied, although material resources, however great, are of no avail without skill and valour in the field. Reserves must be ample because all warfare is infinitely wasteful. The modern war machine consumes all manner of supplies at an incredible rate, including many commodities besides food, clothing and arms for the fighting men; a vast background of industry and supply is necessary to maintain the nation in fighting trim, and to sustain that mysterious quality known as 'morale'. In this, forests and forest products play a great part, less showy, perhaps, than bombs and battleships, those spearheads of the fight, both of which, in point of fact, depend in part upon wood or wood derivatives for their complete efficiency.

From the time England became a naval power, and indeed earlier, none of the nation's greater wars has been fought without extravagant consumption of timber and subsequent spasms of concern for the adequacy of the reserves of growing timber left in the home woods, with attempts to remedy the position, either by legislation to safeguard the remaining woodlands, or by more active measures of reafforestation. It is equally a matter of history that tentative efforts to better a state of affairs which became progressively worse as centuries went by, were never persisted in with sustained resolution. Returns from newly planted woods have seemed too remote to capture and hold the imagination of former administrators, but no one other than a governing authority can assure the continuity of national policy which is the bone and marrow of good forestry. It is no surprise, therefore, that the first of the Great Wars—the one fought to end all war—found the country unprepared in the matter of timber supply. Our home-based assets

were the nucleus of a forest service, far too small to be effective, a conservatively minded and loosely organized home timber trade, and some 3 million acres of woods containing no one knew exactly what in the way of trees suitable for conversion to war-time requirements. Faith, in regard to supplies, pinned apparently incurably to importation, very nearly resulted in disaster in face of the unforeseen development of submarine attack, and, from early in 1916 until the coming of peace, sheer necessity compelled the organization and extensive exploitation of the reserves of timber standing in the woodlands of the British Isles.

According to available returns, woodlands in the United Kingdom amounted, at the time, to:

England	1,697,400	acres
Wales	186,700	,,
Scotland	868,400	,,
Ireland	290,800	,,
Total	3,043,300	,,

These figures, however, are based on voluntary returns, and are known to be incomplete; it is worth noting, too, that of the total area of woods in England and Wales, 541,000 acres, or nearly one acre out of every three, were returned as coppice. What is known for certain is that the Irish woods were decreasing at the rate of 1,000 acres a year and that replanting was not keeping pace with fellings in Scotland; in England the same process was almost certainly proceeding though possibly at a slower pace. The Crown Woods and woodlands in Government ownership did not exceed 3 per cent. of the whole; the remainder was privately owned. It was not known how the merchantable timber was distributed or what the relative proportions were between softwoods and hardwoods. Conifers had been planted extensively in the nineteenth century, and an estimate that home-timber merchants were dealing with home-grown softwoods and hardwoods in the ratio of 2 : 1 gave no indication of the extent of our softwood reserves. Sporting and aesthetic conditions had for years influenced the state of the woods, and mixed open woodland, with undergrowth affording good covert, found most favour; dense stands of clean-grown trees being rare except in the Scottish pine woods. Fortunately the stock of utilizable timber was much greater than might have been expected, a circumstance for which reluctance to interfere with woods, or destroy covert, by felling, the low prices ruling for some classes

of timber, and fluctuations in the prosperity of the home-grown trade were each to some extent responsible. How many sailormen of the gallant Merchant Navy owe their lives to this happy chance it is impossible to surmise, but, be this as it may, many tons of desperately needed shipping were saved for other freights by the cutting and conversion of trees standing in the woods and spinneys of Great Britain and Ireland, for timber is among the most bulky of all ships' cargoes.

There is no indication that a nation in arms will ever be completely safe without unhindered access to forests, and forest products cannot be guaranteed to an island nation from without, as recent events have twice effectively demonstrated; moreover, substitutes for wood, as a raw material, are scarce and unsatisfactory. But forests are of little account without skill and machinery to exploit them. Organized timber production needs trained foresters and woodmen; forest engineers to tackle problems of access and extraction; specially skilled hauliers and transport workers; and, finally, an established and efficient agency for converting round timber into utilizable forms; each of these must be equipped with the tools, plant, and machinery of their separate occupations, because it is upon experienced supervisors, operatives, and their equipment, that war-time expansion of output depends. In combination, they constitute a *cadre* to be filled, in emergency, to the extent required, by recruitment of additional strength, skilled or unskilled, as manpower circumstances permit. We have paid a high price for improvidence in regard to forestry and its ancillary timber-producing trades; scarcity, delays, improvisation and rationing of supplies, tiresome substitutions of unaccustomed woods for kinds better fitted for their several uses, and unhealthy contentions of vested interests, have been the penalties. Not that imports can comfortably be dispensed with, even during a war. Demands for softwoods are insatiable and some tropical forest products cannot be replaced by alternative materials, but timber from abroad costs foreign exchange and shipping space, and wood stacked and awaiting shipment on overseas wharves is of no practical utility unless tonnage can be spared to move it; there is also temptation, when foreign timber is ready and waiting, to argue in favour of diverting ships to carry it which ought to be put to more urgent purposes. We are a sea-trading nation and the thirst for foreign trade is not easily assuaged. Bearing in mind the calls upon labour for armies and industries, it is admitted that imports, particularly of softwood

timbers and processed wooden goods, are justified to the extent that ships' tonnage is actually available, though this is not true of any material obtainable within the country without undue strain.

By far the greater bulk of timber consumed in war, as in peace, is softwood, and, except in regard to a comparatively small number of specialities, its utilization is of the same general nature. Hardwoods fulfil more particular purposes, on the whole, although, in emergency, certain of them are used as substitutes for conifer timbers, beech being the most versatile broad-leaved timber in this respect. Softwood baulks, deals, and boards are needed for building and construction, and for packing material from boards and box-shooks down to the wood-wool shredded from conifer pole-wood; also, in many forms, by chemists, in the ship-yards, collieries, and on the railways, and for a thousand and one different things in connexion with defence and offence and for domestic services. Specialized utilization includes aeroplane construction; spruce, with ash, were of the greatest importance in the aircraft factories in 1914–18. Reserves of Scots pine, located chiefly on estates in the north-east of Scotland, have stood the nation in good stead, in fact it is difficult to conceive what could have been done without this reservoir of first-class material. A debt is due, too, to all those who had planted larch, spruce, and Douglas fir; appreciation of home-grown wood of the last mentioned of these trees having grown as its merits became better known.

Apart from utilization in lieu of conifer timbers, many of the broad-leaved woods are put to specialized purposes for which their individual qualities are peculiarly adapted. First in war-time importance come beech, ash, oak, elm, and poplar, though most of the common species of the country-side contribute their quota to the demands of war. Among the timbers rated more lightly than they deserve by wartime consumers are the medium and inferior stands of oak of which the English woods held, and still hold, large reserves. Oak timber of prime quality, and trees of exceptional dimensions, are valuable in all circumstances, but, in the difficult supply years, the poorer qualities might have been brought more extensively into utilization than has been the case. For instance this material could have been employed almost exclusively as sleepers and crossings by the railways, and for wagon-body building, to mention only two directions in which softwoods, so urgently needed for other uses, are customarily employed. Hardwood coppice constitutes another reserve insufficiently exploited for mining timber; its fuller utiliza-

tion might have saved the sacrifice of many an immature conifer plantation, or at least have allowed some of them to stand for two or three years longer at a period of growth when an extra year makes an altogether disproportionate difference to the yield in pit-props. Younger coppice growth has served for making fascines and ships' fenders, and as faggots for the foundations of aerodrome runways and forest roads. Cordwood has supplied the bulk of the material for charcoal burning and, with waste from the sawmills, helped to eke out coal supply.

It will be remembered that submarine warfare was not fully employed against our Merchant Service in the first of the struggles with Germany until the war had run nearly half-way through its course. The even tenor of home-timber production was hardly disturbed until the shipping position became serious, how serious not many people realized, although it has since been revealed that we were only three weeks from disaster at one period. The unit in which imported timbers are stated in the official returns is the load of 50 cubic feet, and the average yearly quantity of wood, of all sorts, received from abroad in the five years prior to 1914 was 10¼ million loads, valued at £27½ millions, a quantity which dropped in 1916 to 6⅓ million loads for which £40 millions was paid, and thereafter fell to 2½ million loads, costing £29 millions, by the end of the war. These figures do not include wood-pulp, purchases of almost 1,000,000 tons (costing £4·9 millions) in 1914 being reduced to 420,000 tons (costing £12·8 millions) in 1918. The course of prices is particularly arresting; twenty years later 9·4 million loads of timber cost only a little short of £43 millions while the bill for 1·6 million tons of pulp was £14½ millions sterling. Failure of normal timber supplies had to be made good from the only possible source—the home woods—and when needs were made known the response from landowners and home-grown traders was immediate and gratifying.

To assist and augment home supply, a Home Grown Timber Committee was set up in 1915, by the then Board of Agriculture, but this organization was not constituted to stand the strain when vigorous action became urgent, and it had to make way for a short-lived War Office Directorate which, in its turn, was absorbed into the Board of Trade Timber Control early in 1917. The Control assumed entire charge of timber stocks and production, imported and home-grown, and continued to operate until after the end of the war. In total war national requirements take precedence over private concerns, which cease for the time to be measured by

customary standards of individual trading. The true criterion is the value of the service performed in relation to the supreme effort, and the functions of war-enforced control are to ensure supply and to conserve and distribute stocks to the most economical effect, guarding always against inflation of price and eliminating opportunity for excessive profit. The Timber Control instituted systems of rationing and maximum prices for standing and converted timber, gave assistance to the trade, and developed supplementary production chiefly by installing portable sawing tackle in the woods. The output of home-grown timber in 1913, an estimate made in the absence of official returns, was 900,000 tons, and trade production did not increase to any marked extent until after 1915. From then the curve rose steeply until the end of hostilities, supplemented as it was by the output of the government mills. All things considered, a fine effort was made with very little fuss and bother, apart from unavoidable devastations in the woods. In addition, a large part of the timber consumed by the British armies in France was obtained from French forests, and was felled and converted by Forestry Units organized and led by Major-General Lord Lovat, who, in 1919, was appointed the first Chairman of the new Forestry Commission. Their labours were a successful and welcome relief to home-centred activities, which, nevertheless, were called upon to provide hutting and trench timbers, duck-boards, props, poles, and railway sleepers, for the use of the Forces in the field.

It was no easy matter suddenly to bring about expansion of production, almost without previous warning, on the scale achieved, or to meet and overcome the difficulties and deficiencies of organization, labour, and machinery. Men from the Empire Overseas, trained to the work of the woods and sawmills, were quick to rally to the assistance of the Homeland when need became urgent, and lumbermen from the forests of Eastern and Western Canada, recruited into the Forestry Corps of the Canadian Army, and bringing with them much of their own sawing plant, together with a Newfoundland Military Unit, worked wonders to swell output. Forces of Portuguese and Finns, recruited as civilian workers, with the German prisoner-of-war camps organized for forest work, also did much to relieve the labour position. Women, enrolled in the Women's Forestry Corps, took to forest work with enthusiasm and developed a fine *esprit de corps*, finding their service as timber measurers and as woodcutters for pit-propping and lighter tasks of the sort, a hard-working, happy experience. It is interesting to recall

that, in these years, the 'tushing' of logs and haulage in the woods was almost entirely horse-drawn: tractors had not come into general use and the track-laying tractor was a new and undeveloped idea in home-timber operations.

The interval between the two wars saw the inevitable post-war national revival of forestry to which history has accustomed us, but on a more promising basis of public support and legislation than hitherto. A Forest Service was created and replanting and afforestation forged ahead. Forestry found general favour with Parliament, press, and public, although it was too much to hope that a preponderantly town-dwelling nation could become forest-minded, in the practical sense, in so short a time. As much as could be accomplished with the money made available has been done, but more still could have been achieved if finance had been more surely consistent; it may be argued, too, that more private planting might have been carried out had additional public money been forthcoming for heavier subsidies in the form of larger planting grants. Meanwhile taxation remained high, nor were devastations stayed in the woods, because many estates, large and small, changed hands and were broken up, the timber in woods and hedgerows being also felled and disposed of more often than not. However, twenty years' incremental growth was added to surviving stands and young conifer plantations grew up into pitwood and light poles. And then the world was plunged into a second modern Armageddon.

The latest of the wars to be provoked by a German Reich began without inhibitions on the part of the enemy concerning the ethics of total war at sea. The most sanguine of germanophiles could hardly fail, this time, to see that there would be no preliminary respite from the worst that raiding craft could do against our ships, and the mobilization of home resources in all directions was, therefore, a pre-accepted principle. A comprehensive scheme of timber control, based on the experience and, in part, on the policy of 1914–18, came into operation at once; hope that importation might continue on an appreciable scale being soon strangled by horrifying losses of shipping. Once again the nation was thrown back on existing timber stocks and the raw material standing in the woods within the Kingdom, now comprising Great Britain and Northern Ireland. The home trade was somewhat more widely organized than formerly and got more speedily off the mark, not however without experiencing growing-pains. There was hesitation in regard to sawing specifications and the disposal of off-cuts, and

in regard to the conversion of hardwoods, including oak, which a market, temporarily congested with imported wagon scantling, could do nothing to allay. The consequence was that production, except of round mining timber, did not get into its proper stride until well after the collapse of French resistance. What was not immediately understood by all interests was that however much wood could be sawn it could never be enough, and that every equivalent of a ship-load obtained from home-grown trees was a step towards victory. In 1939 the estimated output of the home trade was 800,000 tons—100,000 tons less than in 1913—a quantity which rose substantially in the next year and continued to increase as the war progressed. Departmental production of sawn timber was not encouraged to the extent of the former occasion. Thanks, however, to previously laid plans, the Forestry Commission, which functioned as a part of the machinery of control in the earlier phases of the war, was able to commence direct production of pit-wood without a single day's delay, and to set up an organization for production which, in all its essentials, continued to serve through the drab years which were to follow. Colliery supplies were safe-guarded and means provided to augment the general supply of home-produced scantling, poles, and other produce. The supply of wood charcoal was made secure and importation rendered un-necessary 'for the duration'. The advantage of a national Forest Service with an organized staff, trained to the work of the woods and in the principles of public administration, lay in an intimate knowledge of the country's woods and their resources, the localities in which different species and qualities of forest growth were to be found, and how these raw materials could most suitably and econo-mically be utilized. Without knowledge of these matters it would not have been realized, for example, that all the poles required to maintain the telegraph and telephone services were obtainable without looking farther afield than our own woodlands.

The atmosphere of the so-called 'phoney' war was not helpful; additional plant, machinery, and mechanical transport were not easy to obtain, so many and so diverse did the 'priorities' for war material of all descriptions become. Labour was once more a problem, and a civilian Newfoundland unit was recruited and brought over for pit-prop production before the end of 1939. Help from the Dominions followed, and Forestry Companies of the Australian and New Zealand Armies, and of the Canadian Army in great strength, were soon at work with their outfits. Forestry

12. *Modern Charcoal Burning* 1941. *The*

Companies of the Royal Engineers also contributed, and a body of men from Honduras, wielding their long machetes, were brought in; later on, after the North African victory, Italian prisoners of war became available for labouring work in large numbers.

Despite the well-remembered success of the original Women's Forestry Corps, the formation of a separate Women's Corps for forest work did not this time find favour, to begin with. Instead, women forestry workers were recruited as part of the Women's Land Army and given training, as measurers and wood-cutters, at the Forestry Commission's School for forest apprentices in the Forest of Dean and in The King's Forest in Suffolk, and elsewhere. But the 'Lumber Jills' would not be denied and were eventually embodied under the designation of the Women's Timber Corps. Women have also been employed independently in the woods in considerable numbers. The dilution of skilled labour, and training of additional sawyers, saw-doctors, and hauliers, advanced slowly but steadily; experience again clearly demonstrated the necessity of retaining a strong body of trained timber-working operatives in times of peace.

British woods were combed more thoroughly than before for special products. Veneers and plywood, by virtue of their adaptability and increased commercial importance, were required in quantity, and many home-grown logs have been peeled for these purposes. Prime beech was also sought for rifle butts and fore-ends; poplar for match-making and shoe-soles was so urgently needed that its uses were restricted to specific purposes; wych elm and larch provided boat-skins for the little ships of the Royal Navy, and, as an interesting convolution in time's whirligig, some of the oak trees planted over a century ago in New Forest, with an eye to the maintenance of the wooden walls of Old England, were employed in the construction of types of fast motor torpedo and gunboats which have so successfully and persistently carried the war into enemy waters. Home-grown wood had to be found for pulping to make good shortages of paper and wall-board, and wood-wool was needed for twisting the miles of wood-wool rope used in handling dangerous and breakable articles and as packing material. After the epic retreat from Dunkirk, military demands for defence poles, stakes, and pickets, passed all bounds; enemy incendiarism also resulted in unprecedented calls for spruce ladder poles. Amongst other things badly wanted was boxwood, normally obtained from the Middle East, for the mathematical-instrument makers; clog

makers once more plied their trade in the alder brakes, and uses were found, among many other minor products, even for the pith and wood of elder. Barks, and a number of different forest tree fruits, were added to the supply quota, and once again acorns and beech-nuts were harvested for cattle, pig, and poultry food together with horse-chestnuts for tooth-paste manufacture. It was a new departure in the use of forests to find a considerable area of forest land immobilized by military requirements for training, battle-practice, and camouflage, but the woods so occupied were mainly of the open types, and extractions of produce were not hindered to any great extent.

A full account of British forestry and its labours, and of the further inroads into the woodland resources of Britain, in this second war for liberty remains to be told and totted up; when this chapter was penned, the Hun, though beaten, was not vanquished, and the end was not in sight. What is clear is that home-grown timber has been produced on an unprecedented scale. Two points stand out: the woodland owners have willingly repeated their sacrifices of 1914–18, cases of refusal to cut down woods being exceedingly rare, and the loyal labours of the home sawmillers, who have been well aware that the conversion of timber on such a vast scale must necessarily imperil the future course of their trade. The worst aspects have been wholesale fellings of immature plantations for mining supplies, and the concentration of attention upon the best of the hardwood stands to the relative exclusion of inferior but utilizable qualities. All semblance of age-class distribution, never a satisfactory feature in British forestry, has disappeared, and a hundred years will not be too long in which fully to make good the damage. But a sane forest policy will mend the old woods and add the bulwark of new forests to our defences. We shall then have resources which, even if unwanted again in war, will yet serve to expand our industry and create employment. One of the evils of scarcity is that costs of foreign produce and of its distribution are so easily raised against us. In 1914–18 the prices of the better grades of imported softwoods, normally £20 or less per standard of 165 cubic feet, advanced to between £40 and £50 and have soared to over £60 in this last struggle.

The postulate that timber must be available in Great Britain for use in emergency is incontestable; as an alternative to the further development of British forestry, the storage of sufficient wood for defence purposes has been mooted. The advantages claimed are

that land for afforestation would remain free for other purposes while the expenditure of public money on new forests would be avoided. Surplus shipping would also find employment, and in war-time there would be no need to devote labour to the felling and sawing of timber. *Per contra*, there is the fact that production in general would be enhanced by diverting part of the 16 million acres of rough land in Great Britain from grazing and grouse moor to the cultivation of trees, and, when afforested, this land will certainly maintain more people per unit of area than can hope to find permanent employment under methods known to agriculture; moreover there is the field of employment, too extensive to be ignored, in trades based on the raw products of home forestry. Timber is much more safely and cheaply stored growing on the stump than converted in the stack, although, on the face of it, storage in bulk may be regarded as a feasible measure.

But there are other practical considerations, and, as with afforestation, it is necessary to count the cost. Without plunging deeply into detail, it is fair to say that the accumulation of sufficient reserves, without bringing recurring charges for interest, insurance, and wharfingering into consideration, would cost far more than any expansion of forest policy yet envisaged. Moreover, converted woods are very perishable, and the risk of losses by fire alone, serious at any time, would be a nightmare during a war.

These are matters to ponder over, and what is to be said about the effects of excessive floating stocks on trade? Commercial implications of an intricate nature are involved. The purchase and retention of so huge a stock would spread temporary disorganization among overseas producers and shippers; it would have the inevitable effect of raising prices, while to hold so much merchantable timber within the country would exercise an unsettling, even demoralizing, influence on the trade at home.

It is a far cry from the adze to modern methods of wood conversion, and from the long-bow and cloth-yard shaft of an earlier England to the cellulose-based propellants for steel shells, but first principles stand and wood remains irreplaceable in peace or war. Time, labour, and skill will efface the battle scars from our woodlands, and give back the forest resources now expended, provided no untimely axe is again laid at the root of forest policy as adopted by the Nation. The truth has been spoken from age to age, and it is not blunted to-day—'Let him who desires peace, prepare for war'.

SOME OTHER VALUES

One impulse from a vernal wood
May teach you more of man,
Of moral evil and of good,
Than all the sages can. WORDSWORTH

SAFETY, and a flow of new wealth, are not the sole national benefits to be gained by planting and tending forests. There are other considerations besides those of supply and security, not all of them apparent, at first glance, to those whose philosophies are bounded by the limits of our sprawling municipalities. It is a misfortune that the life of the countryside has become so much a thing apart. Opportunity to become acquainted with country affairs has long been too remote to awaken more than abstract interest in most of those whose daily round lies within the bounds of our greater centres of population, and so the industrial, social, and psychical importance of forests has been obscured from large sections of the community. Country-bred people, too, have often lacked the initiative to look into the secrets of the woods and wood-craft for themselves. And yet, with all this, there is something about forestry and ideas associated with woodlands that touches the imagination in all surroundings, which the up-growth of new forests throughout the country will surely revive and strengthen in the minds of townsman and countryman alike. This is how forest-mindedness is fostered in a nation; the spirit of the old French *mot* that *La France périra faute de bois* might well be taken to heart by those who wish to see some correction of the urban bias, and to have the future development of our country directed in a true sense of town and country planning.

As matters stood in 1919, the forest policy forced upon the country by the ravages of war could only be launched successfully because of the store of accumulated experience which had been handed on from one generation to the next by a handful of zealous enthusiasts for British forestry. Now that a new beginning has been made to raise forests in Great Britain, there is hope that forestry, and the place forest industries ought properly to take in the frame-work of our national life, are also beginning to be realized, and that the realization will slowly and surely gain in strength until, at long last, it emerges from the limbo of public indifference and

neglect to renewed life. But there is a long road to tread before we reawake fully to the heritage of our ancient forest tradition.

The purely social services of forests are far wider than the spread of root and branch. As national playgrounds their potentialities for public good are immense; forests are health-giving and hygienic and are the best natural means of conserving and regulating public water supply; they inspire the arts and stimulate science; and, as a growing source of regular employment, they exercise a powerful check to the lure of the towns.

Something of the scope afforded for employment and manufactures has already been discussed; in this connexion it is important to grasp that the employment resulting from afforestation is *new* employment. In the last twenty-five years our newly planted forests have given positive proof of their labour-absorbing possibilities, a capacity which is progressive until conditions of sustained yield develop, and which can thereafter be maintained at the maximum rate. Employment at this rate is admittedly many years ahead in the case of newly planted areas. Against all this there is allowance to be made for the labour displaced by afforestation. Hill flock-masters and shepherds are chiefly affected, occupations which are not as prosperous as formerly, to judge from recent official Reports on hill sheep farming. Long periods of grazing by sheep, together with indifferent management of the land, have deteriorated hill pasturages; bracken fern has encroached seriously of late years; and the cry is now for drainage and artificial improvement of the herbage, costly demands of which landowners and graziers are not in a position to bear the whole expense. Afforestation necessarily supplants the flocks on the hill-sides planted, but, on the face of it, there appears to be no valid reason why the total head of Black-faced Cheviot and Welsh mountain sheep in the country should be reduced provided suitable land improvement schemes are adopted and the standard of management improved. A slightly greater density of sheep on the lands taken in hand for improvement would make good most, if not all, the difference in total sheep stocks. The implications of the sheep problem as affecting the expansion of British forestry and the production of timber in relation to mutton and wool, are dealt with in considerable detail in the *Report on Post-War Forest Policy*, published by H.M. Forestry Commission in 1943.

One of the baffling social problems of our time has been to draw men and their families 'back to the land' and to make the

attraction permanent. Public-minded men have not spared their energies or means in the quest for a solution, and governments and local authorities have taken a hand, but the movement has not met with unqualified success anywhere, one of the stumbling-blocks being the difficulty of subsistence while the small-holder is settling down and learning his job. This period is often long, and always tends to be disheartening unless there is opportunity to earn a regular wage to supplement the cost of living in the meantime. Small-holdings are natural adjuncts to forestry; permanent settlement in and about the forest being especially necessary in remote districts where the supply of milk and vegetables is difficult. Settlement in small forest holdings, up to 10 acres each in extent, with a safe background of wage-earning, is probably the soundest of all bases on which to repopulate the desolate mountain valleys of Wales and the North-West, and the silent glens to the north of the Highland Line, where derelict cottages and deserted crofts speak eloquently of a husbandry that has vanished, and where the sheep-walk and deer-forest have conspicuously failed to hold all the former dwellers. Many thinking Scotsmen and Welshmen believe that one of the chief hopes of restoring prosperity in upland districts lies in afforestation. That new forests would, in due course, bring men, money, and prosperity to the valleys and barren mountain-sides is certain.

Forests, as playgrounds, are almost a new thing in this country, and the great group of State forests thrown open to the public for recreation and enjoyment in 1937, by the Forestry Commissioners, in co-operation with the Corporation of the City of Glasgow, as the Argyll National Forest Park, marked the first practical conception of a national park in these islands. The Argyll area comprises about 85 square miles of mountain and moorland, situated to the west of Loch Long, some 20,000 acres of which are in course of afforestation. This National Forest Park is a people's playground in the truest sense and, one day, will also be a noble forest; there can be no better way of making forests and forestry known than to encourage access to them. The simple regulations imposed are irksome to no one and visitors are invited to share the duty of protecting the plantations from harm. Carelessness with fire is the great danger. This new adventure in British forestry met with instant success, and its welcome has been sustained. More new National Forest Parks have been dedicated by the Forestry Commission on the Argyll model, one in the

vicinity of Snowdon, in North Wales, and another in the ancient Forest of Dean. Others in view are in the Lake District, and in the Southern Highlands of Scotland in Galloway, and, but for the interruption of war, these two further areas would already have been made available for healthy relaxation and enjoyment for campers, ramblers, and those interested in nature study and out-door pursuits. In this practical way the work and aims of forestry are open for all to see and learn; but there is even more in the movement than this, because to foster a love of out-of-doors and an interest in things that live and grow in the open, is to render a service of real sociological and educational importance. The National Forest Parks have the additional merit of exceedingly low cost to the taxpayer.

In the minds of many people, forests are associated with excessive humidity. As a matter of fact the forests of temperate climes do not tend actually to increase local rainfall, moreover it is certain that planting, to the extent afforestation is practicable in Great Britain, will not affect the normal precipitation of moisture in any district. However, forests do exercise other well-recognized climatic influences, all of them moderating in their effects. Woods are damp or dry according to the nature of the soil and the extent of natural or artificial drainage; what happens in woodland is that water, in the form of rain, snow, or rime, is collected on exposed leaves and branches and drips or trickles down to the soil beneath. As water gravitates downwards from the canopy of the tree-tops evaporation is checked, and the humus layer, acting like a sponge, absorbs the drip and allows it to soak away into a soil and subsoil rendered porous by penetrating root systems, from whence it percolates gradually to springs and watercourses. Seepage is thus encouraged and run-off regulated. Some moisture is, of course, lost by evaporation, and transpiration, one of the natural functions of the foliage, releases large quantities of water to the atmosphere, but these processes are not confined to forests. In open country the quantity of rainwater lost by surface run-off to streams and rivers is enormous; where there is vegetation of any sort transpiration is also active.

A forest acts as a natural reservoir and filter, and, for these reasons, and because risk of bacterial contamination is reduced, the planting of water-catchment areas is strongly advocated. Great water undertakings, such as those of Liverpool and Birmingham, at Vyrnwy and Rhayader in the Welsh mountains, to mention

only two, have planted extensively on their gathering-grounds. Conifers, with their dense canopy, afford the best hygienic conditions; the leaf-fall of broad-leaved trees is apt to be troublesome and deciduous species do not at all seasons give such effective cover. Pure water and public health are synonymous terms, and, where water is drawn from forested watersheds, it is recognized as being more free from harmful germs than it can possibly be when collected from grazing-grounds and lands in human occupation, however sparsely occupied.

Farm lands adjacent to forests benefit from the gradual release of water from the woods, and from reduced dangers of flooding and erosion. The penalties of forest destruction are scored deeply on mountain and plain in all parts of the world from which forests have disappeared and where, in consequence, periodic floods play havoc with the lives, health, and property of the inhabitants. Destruction of vegetable growth, including forests, has hardly ever failed to bring grief and loss to the peoples concerned; as a countermeasure to soil denudation, there is nothing more sure than the planting of trees. The famous Tennessee Valley Authority was brought into being by troubles arising from soil denudation, and has recognized the benefits of tree-planting. Light soils and sands also suffer from wind erosion. French engineers did not succeed in fixing the shifting dunes of the Landes until they covered them with pine forest, an historic work of afforestation which not only stopped the dangerous drift of sand across the Gascon plain, but brought with it prosperity and health to what was previously a derelict and ague-ridden locality.

Beneath the forest canopy the air is cooler in spring and summer and warmer in autumn and winter, as a general rule, the differences being more marked in conifer than in broad-leaved forests; nor do day-to-day temperatures fluctuate among the trees as in unwooded country. Soil temperatures are affected in still greater degree, less heat being lost by radiation, and soil warmth being conserved by the insulating blanket-like humus layer. Yet another ameliorating consideration is shelter. Nearby lands are shielded from the cold storms of winter seasons and the persistent drying winds of spring, life being made more comfortable for man and beast. Protection arises from direct interception of wind and gales and by the retarding effect of trees in the mass, which act as a brake to the force of air currents. Forests produce the strictly local effects of shelter belts over much wider ranges of territory.

It cannot be disputed that the protection conifer and broad-leaved forests give from extremes of climate has affected health for the better wherever such forests occur, nor can it be doubted that public benefit arises from the acknowledged degree of sanitary purity possessed by forest soils, and because the air among the trees is many times more free from injurious matter than dust-laden atmospheres in the open. Medical men now seem to rely on atmospheric purity, rather than exhalations from the trees and their resins, to account for the health-giving effects of forest air, which is classed with the bracing airs of mountains and the sea-side. Sanatoria and convalescent homes are established in forest surroundings for this reason, and because of their sheltered quietude. Nowadays, when the mythical woodland dragons and evil spirits of the Dark Ages, and even later years, have ceased to exercise their terrors, a soothing calm pervades the woods that is psychologically helpful to tired souls and bodies; in plain fact there is nothing at all that is harmful or unhealthy about a well-managed forest. And the effects of forestry upon general welfare are not confined to human populations.

Forests give sanctuary to wild life. Every forest is a potential nature reserve for birds, beasts, and numerous insects, particularly for species whose numbers have been dangerously reduced in Great Britain. Some have gone within the life-span of the present generation, and others are on the verge of extinction for want of safe covert. Forests offer the protection badly needed by several British species, and may be the means of saving those native races whose numbers have been brought low; in the West Country, ravens and buzzard are already breeding in plantations made since 1919. Forests also have long-standing associations with the sport of hunting and of shooting, and, although silvicultural conditions do not altogether accord with modern ideas of game shooting, forests harbour beasts of the chase and game birds—the battues of hand-reared pheasants, which became fashionable with the development of the breech-loading ejector, are admittedly a business of moderate-sized coverts and not of extensive tracts of forest. Present-day hunting, too, looks with more disfavour on large expanses of woodland than older exponents of the arts of hunting and hound-work were wont to do. Altogether, the influence of fashion in sport has had a greater effect on the management of private woods in the past half-century than is frequently recognized. Sport and forestry, however, are not incompatible,

and if either hunting or shooting fails to survive the changed social conditions of post-war years, the reasons will lie farther afield than in the forester's work and the upgrowth of newly planted forests.

The stage of 'Merrie England' of tradition was set in the greenwood and, to the mind's eye, a modern Britain without woodlands is inconceivable. Forestry has been a preserver of characteristic local beauty and a great improver of landed estates, each of which is a unit on the broad plan of the country-side, to which few of the enterprises of ownership have contributed more richly than planting, whether trees have been planted for scenic effect or out of a sense of duty to successors; for game covert; or from sheer pride of ownership and the pleasure of seeing woods grow. Tall trees and great woods may hide a vista here and there, or obscure an outline, but, from Cornwall to Caithness, woods of oak, ash, and beech, or of larch, silver birch, and the darker-hued pines and spruces, are part and parcel of the familiar landscape in many parts of the country in which, by good fortune, our heritage of landscape beauty has escaped the blight of industrialism. But too often aesthetic considerations have weighed lightly in the balance against material progress and development. The industrial revolution, and the scramble for wealth that followed, robbed many fair places of their woods or have created conditions in which trees cannot flourish; it is possible to call to mind many localities, formerly standing thick with trees, that are now bare, desolate, and utterly spoilt by mining or manufactures. Even so innocent a pursuit as sheep-grazing cannot be held blameless, for sheep have stripped the mountain valleys of their flanking growth of natural forest. All this extensive spoliation is the cause of a distress which is seeking relief in planning; but in this there is also an element of risk, because planning, now taking the field with a capital 'P', will, if applied with too heavy a hand, clash with the very characteristics it is desired so ardently to preserve. Planned utilization of land is not the simple matter in this country that it is in countries where similar soils and like conditions of terrain extend over huge territories. So, over most of the map of Great Britain, planners must be content to use a finer brush than one adapted to depict broad bands of zoning.

Newly planted forests may, at times, offend the aesthetic conscience, and feelings are stirred by some aspects of their early growth and by fears regarding their future development. A duty is clearly laid upon forestry to adapt its work to the landscape and to

blend plantings with the contours in such manner as to avoid harsh contrasts. On the other hand, too sensitive an appreciation of the scenic beauty of the moment may sometimes mislead. Nature never stands still and it is an elementary proposition that everything must have a beginning. It is affectation to claim that the appearance of newly planted forests, at the moment, must needs outweigh their scenic possibilities in the future, and that they will not, as they grow up, merge with their surroundings to become landmarks of local and national pride. There are also heartburnings when woods come to be felled. Regimentation is the word invoked in disparagement of a young plantation, but perhaps the most stereotyped of regimented plantings made in this country at any period were those of the school of Capability Brown, many of which, with the passage of time, have grown into woods of sylvan charm. It is not beyond the art of forestry to achieve splendour of effect, even if the mass of the forest is composed of conifers, as much of the new work must be if it is to serve its primary purpose to the nation. A healthy and properly managed forest, in which species suited to the silvicultural conditions of the soil are grouped in natural proportions, possesses attributes of grandeur fully in keeping with true aesthetic judgement. What disturbs is newness, but we can replace the forests that have disappeared only by artificial means, and the fact that newly planted trees develop into high forest and at the same time become economic timber-producing assets, is not always recognized. Patience and tolerance are the qualities required to bring about the ultimate results; new forests are unlikely to be fully acclaimed until they have been absorbed into a nation's social and economic system and have become an integral part of the life of the people.

All that a civilized community derives from the possession of forests is not measurable by rigid standards or a materialistic yardstick. From primeval times the imagination of mankind has been stirred by the awe and mystery of forests and, later, by their manifest utility. Veneration of trees was one of the earliest forms of worship, a reverence widespread among the peoples who laid the foundations of our historical record. Ancient mythologies abound with references to forests and trees. According to very ancient beliefs, men sprang from the trunks of trees and the oak and ash have been regarded as the sources of human origin; belief in the close relation between the lives of men and of trees, which were endowed by the ancients with a sense of feeling and

power of speech, is traceable through numerous channels and perpetuated in the classic writings of Greek and Roman authors and in the legends of ruder races. It has been suggested that a vestige of this idea may linger in the custom of recording descent in the form of a family tree. Other myths conceived the Universe in the form of a tree, and Yggdrasil, the great ash tree, or Tree of Life, of the Norsemen, had roots and branches that bound together heaven and earth and hell. Ancient Britons worshipped in oak groves and, under the tutelage of the Druids, regarded the parasitic mistletoe as holy. Trees symbolize fertility and were believed to possess powers for good and evil; to protect from disease and witchcraft; and to control rainfall, a faith which, in some degree, seems to have endured to the present day. Superstition has long memories; rowan is known as a specific against the evil eye in Scotland, and ash poles, split longitudinally to make an aperture through which to pass a ruptured child to effect a cure, were to be seen in west country woods in years not long past. The cult of fertility survives in the revels around the village maypole, and researches into matters of anthropology yield ample evidence to show how indelibly forests and trees have impressed themselves on the minds and customs of men of successive ages and cultures.

The origins of national culture reach back to natural phenomena and objects as our forefathers encountered and interpreted them, and to memories of scores of legends, originally passed from man to man by word of mouth, and so preserved until more permanently recorded. Forests and trees weave, as a thread of green and gold, right through the folk-lore and folk-music of Europe. Belief in dwarfs and witches, and elves and trolls, kindly or mischievous folk possessed of supernatural powers, has always been intimately associated with the woodland scene; the tales of Grimm and Perrault, to mention two of the writers of fairy stories well known to English childhood, point unmistakably to primitive folk-tales first conjured up in the half-fearful minds of dwellers among the lights and shades of great forests, and amid the wild creatures of the woods.

Masters of poetry and prose have crowded their works with references to woodland life, and some of the greatest authors have drawn impulse direct from the well-spring of the forest. All that the Arts owe to wooded hills and dales and forested plains is a debt too deep for us to gauge. Music has caught countless airs and

harmonies from the murmuring of breezes in the trees, the rustling of leaves, and the rhythm of branches swaying in the wind or creaking and groaning beneath the stress of storm. Forest voices, even the ringing of the woodman's axe, are full of melodies, and wood itself is the medium of some of the sweetest of all instrumental music. Artists have been moved, over and over again, to capture the tints of the woodland seasons and to impress the effects of sun and cloud on bark and foliage, and the majesty of tall trees, upon their canvases. The profusion of colour in the sunshine and shade of forest glades, the deeper contrasts of light and shadow within the forest, and the red-gold tints of autumn have never failed to arrest the artistic eye.

Applied arts also respond to the inspiration of woodlands and trees. Architecture has modelled freely from the finely proportioned columns crowned with the arched limbs and delicate tracery of interlacing branches. Stately aisles of the forest gave form to the classic styles of ancient Greece and Rome; the same concepts are betrayed plainly in the designs of later periods, in particular in the pointed arches and decorations of Gothic stylists, which derive their grace of form directly from the trees of the forest.

The spirit of the forest and its trees has always been a potent factor in prompting speculative genius; it pervades our arts, philosophies, and daily life, and must bear a share of responsibility for moulding us into what we are. In more mundane spheres, wood has proved itself one of the most intriguing of materials for experiment and invention, as well as an urge to fine craftsmanship. It is no flight of fancy to say that the greatest of all the immeasurable services forests have rendered is that they have given men cause to think and invent.

The sophistications of the era in which we live, and the pains and extravagances of war and peace, have done nothing to dispel the charm and mystery of forests and forest lore. In this, and in our growing dependence on the cellulose and lignin of the wood of trees, rests the hope that Britain, to an extent befitting her altered circumstances and the still growing needs of her large population, may once again become a forested land; that people may learn to roam at will in the nation's forests with understanding and protective care; and that forest industries may, henceforward, occupy a more worthy place in the economics of our countryside.

NATURAL HISTORY IN THE WOODS

The knowledge of man is as the waters, some descending from above, and some springing from beneath; the one informed by the light of nature, the other inspired by divine revelation.
FRANCIS BACON

A FOREST has been variously described as a commonwealth, a community, or an association of living plants and living creatures. Forests are vital organisms in which the component organisms share conditions in common, their needs being largely interdependent. Forest denizens range from some of the highest forms of life to many that are very lowly, and the profusion of species renders woodland of all types a veritable paradise for students of natural history. The dominating partners in a forest association are, of course, the trees, with which grow shrubs, flowering plants, ferns, mosses, lichens, and fungi, the whole forming a wealth of vegetation which affords means of shelter and subsistence to animals, birds, reptiles, insects and, where rivers, lakes, and ponds occur, to fishes and other aquatic creatures; a vast population of microscopic life, animal and vegetable, is also to be found both above and below the forest floor. In this concourse of living things so intimately domiciled together, each separate species lives out endless successive cycles of the life-history of its kind in the general harmony imposed upon all wild life included in natural communities, a harmony that spreads as a mantle over the perpetual striving of one species against another in the universal struggle for existence. When natural forest is brought under systematic management, the endeavour is to regulate this heterogeneous, self-governing population to the advantage of forestry, seeking always to avoid sudden or drastic interference with natural prescriptions that are kindly to tree growth. This principle applies also to the planning and management of artificial plantations, in which a properly balanced association must be built up with the same regulating care, for the good reason that it is impossible to reproduce and preserve even a simulation of a forest community without giving encouragement to all necessary elements. Rigid, totalitarian ideas can be relied upon to bring their reward of disappointment and disillusion. Owen Seaman's lines are apposite:

> New Art would better Nature's best,
> But Nature knows a thing or two.

Nature cuts her coat according to the cloth available at the moment, she does not work to any rigidly fore-ordained, long-term plan, but there are natural laws that are eternal and which cannot be ignored with impunity, laws into which science continually inquires and which, as far as their truths touch upon the production of timber trees, are also the quest and study of foresters in all climates. Observation and experiment engage in constant delving into the mutual relationships of multifarious forms of forest life, some well recognized as beneficial to silviculture and some, very decidedly, the reverse; others, in the present state of knowledge, can be regarded as neutral. If, by any concatenation of circumstances, a single member of the woodland flora and fauna is favoured in greater degree than its associates, it usually flourishes amazingly, and may become a plague. There are species, too, which act as checks to the exuberance of others, and these, so far as they reduce the activities of forest pests, are protectors of trees. But enemies to tree growth are also numerous, such as foliage-destroying insects, parasitic fungi, rabbits, and also wood-pigeons whose autumnal flocks will clear the mast of oak and beech, thus hindering regeneration. Friends and foes are distributed with lavish impartiality throughout the animal and vegetable worlds, and no inconsiderable part of the forestry problem is to harness friendly forces to the tasks of protection and conservation and to control the numbers and actions of inimical species. In the extension and application of knowledge of this kind lie some of the best safeguards against diseases and pests. Many factors are obscure; ways and means of bringing vegetal and animal populations into correct relation to achieve a specific object in view are rarely easy to discover, and are less easy to arrange artificially. Foresters must follow Nature's ways, adapting them as closely as they can.

In the mountain regions of the mainland of Europe, which are the last European continental strongholds of primeval forest, the natural arrangement of different species of trees is often in the form of zoned belts, beginning with oak and, as the terrain rises, continuing in upward succession with conifers. These belts or bands are seldom sharply defined and one species may merge into the next above through zones that are common to both. In the lowlands, oak is often associated with other broad-leaved species but, in Northern Europe, conifers, with or without birch and aspen, stretch inland almost from sea-level. Afforestation in Great Britain is concerned with planting the most useful trees that soils and climate allow,

13. *Roof Tracery, Exeter Cathedral: showing 'The tricks of Art that builders learned of trees'*

Reprinted from *Exeter Sketches* by courtesy of Messrs. E. & K. Shapland, Exeter

allocating the plantings to the best advantage of species and terrain. Reafforestation may seek to establish the former species over again; this would certainly be the case wherever mother trees are left standing to re-seed the area, a work that is aided by wind and the birds. Many seeds, including those of all the common conifers, are equipped with wing structures to assist dissemination, and are often scattered far and wide by winds. Where heavy seeds like acorns and beech-mast are distributed beyond the radius of parent branches, the work is usually attributable to birds and squirrels, with dormice, and other small rodents, also lending a hand. Some minor broad-leaved species and shrubs are spread by fruit-eating birds which, in general, do not digest, and thus destroy, the seeds of wild fruits, as true seed-eaters are able to do. Where elder springs up mysteriously in a plantation, its presence can safely be accounted for by roosting fruit-eaters, probably thrushes, blackbirds, or starlings. Missel thrushes and others are greedy eaters of holly and mistletoe berries and the fruits of ivy, and the attractive red fruits of honeysuckle, a very tiresome forest weed, are not overlooked. The seeds of wild clematis, or travellers' joy, another troublesome climber which limits itself fairly closely to alkaline soils, rely for their distribution upon the feathery awns with which their carpels are equipped.

Characteristic flowering plants make their homes in woods in profusion. The wild hyacinth, the English bluebell, with wood-anemones, primroses, dog's mercury, and wild garlic, spread carpets of bloom and greenery in spring-time and are followed, later, by groups of foxgloves and willow herb, to mention only a few of the most striking species. Several varieties of our native orchids, and the helleborines, raise their blossoms amid the protective undergrowth; herb paris, daffodil, and the lily of the valley are more localized and rarer. Foxgloves, which yield the medicinal digitalin, spring up in extraordinary profusion in forest clearings, and the rose-bay willow herb (*Epilobium angustifolium*), a native plant described in standard books on British botany as widely spread but not common, has become very plentiful throughout most of the country in the course of the last twenty-five years, especially in clearings caused by fellings and woodland fires. It is no new thing that its numerous seeds are borne long distances by wind, and the remarkable increase of the species in woodlands, and in open country, can only be attributed to circumstances which are not fully understood, or to some equally ill-recognized whim of nature. The plant is called 'fire-weed' in

North America, because its dull red blossoms, flame-like in the mass, are conspicuous over the great expanses of burnt-out forest left after the appalling forest fires which occur periodically in Canada and the United States.

Flowers and grasses share the forest floor wherever sufficient sunlight penetrates the overhead canopy, and some are content with no more than a relatively small measure of diffused light. Wood-loving grasses include the woolly holcus, wood and false bromes, tufted and wavy airas, the spreading milium and the dainty wood melic; *Calamagrostis* is a localized species and *Molinia* occurs on wet, peaty soils. Stiff and soft-leaved rushes and wood sedges add to the verdure, and ferns abound in the damper woods—male and lady ferns, hart's-tongue, ladder fern (*Blechnum*) and the polypodys, which are so completely at home on the mossy trunks and limbs of trees in the damper woods of Western Britain. Owing to the depredations of collectors, the regal osmunda has become a rarity in English woods. Bracken fern is happy only where direct light penetrates and soon dies out beneath the shade of dense foliage. The horsetails, with *Sphagnum*, *Polytrichum*, and other mosses, liverworts, and lichens complete a brief survey of the woodland plants. The full catalogue of plants to be found in our woods is a long one and some of the species are rare; all are a joy to behold in their natural setting, but a lush growth of ground herbs, such as quickly springs up where timber has been cleared, is troublesome and competes severely with young trees for light and moisture.

The rhizomorphs and mycelia of fungi penetrate everywhere, and fructifications are numerous on and beneath the surface of the soil and on the roots, stems, branches, and leaves of the trees. Parasitic species include some of the forester's deadliest foes, although not all fungi are seriously harmful, a large proportion being apparently inoffensive. A limited number are wholesome as food. Certain types of soil fungi have definite affinities with the root development of trees, forming those interesting root structures known to botanists as *mycorrhizae*. Toadstools of different shapes and colours, from dingy whites and browns to vivid scarlet, occur frequently in woods, also bracket, branched, and chip-like fungi; root and butt rot fungi; and bark-destroying, blister, and canker fungi; all feeding and growing upon living or decaying vegetation according to their parasitic or saprophitic natures. Parasites feed on living tissues, the saprophites contenting themselves with dead material. Honey fungus and larch canker are examples of the

former and the familiar coral spots of *Nectria*, often to be seen on dead sycamore branches, of the latter. Edible species include truffles, which occur in some of our beech-woods, also the morel, the edible boletus, and others. Other kinds are dangerous and the fly agaric is deadly. Moulds and mildews complete the tale of forest fungoid life. Much is known, and there is much yet to be discovered, concerning the inter-reactions of this great assembly of forest plants, of which it is scarcely safe to say that any is without significance in silviculture.

The ancient forest fauna of Britain, so rich in remarkable species in successive epochs, has experienced a series of declines caused by variations in climatic conditions, the steady increase of human population, and the limitation of woodland covert. No animal dangerous to man now dwells in our forests, and the only traces left behind by the great beasts of earlier ages are their fossilized bones. The sabre-toothed 'tiger', woolly rhinoceros, and mastodon died out long ago; gone, too, some not very long since as science counts time, are British species of the lynx, aurochs, elk, and the great 'Irish' deer. Brown bear, beaver, boar, and wolf have been exterminated within historic times; boar were still hunted in the sixteenth century, and the last native British wolf was not destroyed until about two hundred years later. The pine marten is now our greatest rarity and is narrowly escaping extinction; as the few remaining pairs are scattered over some of the wildest areas left in the country, there is hope that the sanctuary of new forests will enable the British race of marten to survive. Several of our remaining wild creatures were able to strengthen their numbers in the war years of 1914–18, owing to the relaxation of gamekeepers' activities, an opportunity of which the British wild cat took advantage to increase in numbers and range in the Scottish Highlands, and, by all accounts, the increase has been maintained. The same circumstances have somewhat improved the position of the British fitch, or polecat, now not uncommon in parts of Wales, occasional specimens being also reported elsewhere. It is a criminal thing to persecute the Island races of our few remaining carnivores to the point of extinction, and it is to be hoped that indiscriminate killing will not much longer be tolerated, although it is admitted that none can be allowed to become a nuisance.

The history of rare birds in Great Britain is even worse than that of the mammals. Several species have been exterminated in recent times; everyone knows of the treatment meted out to that remark-

able seabird the garefowl, or great auk, of which not a single specimen remains alive, and other birds, some of them forest dwellers, if not completely killed out, have been lost as resident and breeding species. The white-tailed eagle and osprey have vanished in our time and a full list of the losses is longer than this. The kite, so numerous a century ago, is reduced to a mere half-dozen pairs, a precarious position that is not improved by the persistent harrying of egg-collectors, whose depredations continue in spite of the Wild Birds' Protection Acts and vigilant watching. It is a dismal fact that these well-meant Acts, and their administration, have proved an inefficient safeguard. Hawks get very little peace, the only species making headway being the common buzzard, a useful killer of rabbits. Game preservation, collectors, and cheap shot-guns have a great deal to answer for; no conspicuous, or rare, bird is safe and it is indeed fortunate for hawks and owls—firm friends of forestry and agriculture—that the evil and illegal pole-trap is nearly (but not quite) a thing of the past. Whether the present war is affording the same respite to wild animals and birds that they enjoyed in the last, is open to question. The energetic but not always well-directed use of lethal gas, and ill-controlled laying of poisons, constitute a grave danger to the rarer denizens of our woods and country-side; strychnine and other poisons are far too easily obtained and used, and in reckless hands are playing havoc with irreplaceable sections of our fauna. Poisons are no respecters of species.

Badger, otter, fox, stoat, and weasel, also hedgehogs, hold their own in spite of traps and poisons; that they have done so hitherto is good evidence that they will continue to survive. Badgers have a sett, or earth, in most of the older woodlands, except in the extreme North; in some of these ancient strongholds in the English woods, the badger, fox, and rabbit, all occupy quarters in the same workings. Foxes multiply rapidly if not molested and vigorous methods have to be employed against them; stoats are also prolific and require to be kept in check; but, apart from an occasional rogue, badgers are harmless, to say the least of it. And despite fishermen's condemnation, the otter is an energetic killer and eater of the spawn-destroying eel. The reduction of carnivorous animals and birds of prey is one of the chief reasons why the ubiquitous rabbit continues to increase and multiply, rabbits being a staple food of some of these expert killers, whose numbers, if permitted, will always adjust themselves to the limitations of food-supply. Weasels prey chiefly on small rodents, and perform a useful service to foresters by keeping

mice and voles within bounds. Moles, which shun dry woods, tunnel industriously for grubs and worms along ride-sides in the damper areas; they are greedy eaters and so is the tiny but aggressive shrew, whose operations are entirely without harm to trees.

The largest animals now running wild in British woodlands are the deer. Red deer and roebuck are natives and both are forest dwellers; conditions in most of the so-called Scottish 'deer forests' being quite foreign to the true woodland nature of the former species. Wild red deer roam throughout the hills of Scotland; they are also to be found in a wild state in the Lake District, on Exmoor and the Quantock Hills, and in New Forest. Everywhere they enjoy a certain measure of protection, but roe-deer, the most truly feral of the British deer, have ranged wild and unprotected in the North wherever they have been able to find woodland covert; they have also retained a foothold in several parts of England, and are to be found in other districts to which they have been reintroduced. Roe can be destructive little beasts; their numbers have to be reduced from time to time, although it is safe to say that no practicable method of regulating them is calculated to rob Great Britain of her native race of roe-deer. The fallow deer at large about the country are generally regarded as the progeny of individual animals which have escaped from semi-domesticated stocks in private parks. The wild fallow deer in New Forest may, however, have had more ancient origin, and the true status of the species in Britain is not clearly defined. Japanese deer, muntjac, and a water deer from China, have strayed from enclosures and become locally acclimatized of late years. Wild deer of different kinds, especially fallow deer, are more numerous than many people imagine, their tracks or slots are frequently to be seen along forest rides. Small herds of wild goats, probably the last relics of domestic herds of long ago, continue to graze in a few places on the hills of Wales, the Border Country and the West of Scotland. Although diminutive in size, the old billies carry imposing heads of spreading scimitar-like horns. They are interesting survivals, and as they do little damage to plantations or anything else there is no need to interfere with them.

The rodent family includes some major forest pests, not forgetting the rabbit, about whose misdeeds no one who is concerned with forests can have any doubt. The introduction of rabbits into Australia, and the nuisance they have made of themselves there, appears to have been yet another case of history repeating itself. Naturalists believe that rabbits were not originally a native species

in Britain any more than in Australia, but consider they were brought into England and acclimatized at some early period of the Norman dynasty, round about the twelfth century. This is as it may be, and certainly no fossilized rabbit remains of earlier date have come to light, but 'brer rabbit' has made the most of his opportunities, just as he has, more recently, in the Antipodes, and is now an unmitigated and expensive pest from which few British woods are free. Brown hares love to seek quietude in the woods on occasion, and to whet their incisors on the shoots of young trees; the blue mountain hare, now confined to the hills and moors of Scotland, apart from an isolated outpost at the Derbyshire end of the Pennines, also damages young moorland plantations, especially in winter when other food is hard to find.

Red squirrels are equally at home in conifer and broad-leaved forest and live only among trees. Periodically, and in particular districts, they become very numerous, and do much damage to woods which become infested. Squirrel populations are subject to unaccountable fluctuations, commonly attributed to the cutting down of woods, but now known to be due to coccidiosis, an epidemic disease that is very deadly. The species almost completely died out in Scotland in the eighteenth century; the record of its recovery, both by natural means and by the reintroductions which were made, makes interesting reading. Similar disappearances on a smaller scale have occurred in the Forest of Dean and other districts. Red squirrels were plentiful enough in the Forest of Dean thirty years ago but afterwards vanished and only began to return within the past decade; in this case the marked variation in numbers was certainly not due to timber-felling. The Carolina grey squirrel, an alien species, frequently and rather ridiculously called a 'tree rat', has spread from the places in which it was originally turned loose and has become common in various localities about the country. It is not a desirable addition to our fauna though we have only ourselves to thank for its presence. The grey squirrel has been proscribed by the Ministry of Agriculture, but nothing less than a concerted and persistent campaign will now dislodge it from the suburban areas and woodlands in which it has established itself. Incidentally grey squirrels are good meat.

Rats invade woodland now and then, but life in a forest is seldom sufficiently satisfying to encourage these artful dodgers to remain as permanent residents. The long-tailed field mouse and voles are in a different category: their congregations among young trees

increase and decrease by cycles and numbers are sometimes incredibly large. In the aggregate the losses these little creatures cause in forest and field add up to a serious total. The silly, indiscriminate killing of hawks and owls and small carnivorous mammals cannot be acquitted of responsibility for periodic plagues of the lesser rodents, other controlling influences being food-supply and disease.

Standard forestry text-books, one and all, are disappointing in their attitude to the subject of wild birds and the influence they exert on forestry and forest trees. It is beyond dispute that most species of birds are important factors in the economics of forestry, much more so, in fact, than many foresters realize. Birds are eaters and distributors of seeds; some destroy buds, bark, and timber, and certain of them kill other birds and animals, but many species share the work of destroying enormous quantities of insects. Attempts to make rough and ready lists of the birds injurious or helpful to forestry are useless. A close study of their habits and dietaries is needed and these matters have received little attention in this country from the standpoint of silviculture or, for the matter of that, from the point of view of the farmer. Wild birds, on the whole, are among the forester's best friends, indeed, as knowledge increases, it becomes less easy to regard woodland birds with indifference, provided the distribution of species remains reasonable. Bird distribution and densities are governed by their habits, the quantity of food, water, and nesting-places they can find, by the seasons, and by the freedom afforded from foes. Broad-leaved and mixed forest with undergrowth provide the best conditions and a large number of the British breeding species make their homes in woods of these descriptions. Food, water, and nesting-sites are essentials. Some of the busiest insect-eaters frequenting woodland nest in holes in trees, but suitable natural nesting-holes are not always numerous in a well-managed forest. This fact is important; in the light of observations made in continental forests, it is clear that care should be taken to provide acceptable nesting accommodation by means of nesting-boxes and, for the warblers and others, by encouraging undergrowth. About two nesting-boxes to the acre is the right distribution, and to ensure that at least two are occupied it is safer to provide three.

Fewer species of birds habitually resort to conifer woods than are found in broad-leaved forest, lack of water not infrequently being among the reasons for gaps in the bird population among conifers.

Birds love water; one way to make dry woodland more attractive is to provide drinking-places. The absence of convenient nesting-places is usually another disadvantage. Coal-tit, crested tit, crossbill, gold crest, siskin, long-eared owl, and capercailzie are birds of the pines and spruces, but a number of others can be attracted to conifer plantations that are not too dry and draughty, including:

Great tit
Blue tit
Long-tailed tit
Wren
Robin
Redstart
Nuthatch
Tree creeper
Chaffinch
Starling
Thrush
Missel thrush
Cuckoo
Nightjar
Wood-pigeon
Green woodpecker
Great spotted woodpecker
Raven
Crows
Jay
Magpie
Owls (except short-eared owl)
Hawks.

There has been reason to fear that war fellings of Scots pine on the north-east of Scotland might further reduce the already restricted habitat of the crested tits, a British species which breeds only in these parts, but happily reports are to the contrary. The capercailzie also occurs only in Scottish forests. By some freak of nature that the earlier destruction of pine woods does not wholly explain, this handsome bird died out about 1770. It was reintroduced from Sweden in the first half of the nineteenth century and has firmly re-established itself in its old haunts as well as some new ones.

Pheasants, woodcock, and wood-pigeons are woodland birds. Most of the song-birds and warblers nest in the undergrowth; they are chiefly insect-eaters and so are exceedingly useful members of the forest community, moreover most species, including the hard-billed seed-eaters, feed their young on insects and insects' eggs and grubs. The consequent check to the insect horde, at its most vulnerable and damaging period, is an exceedingly valuable one because the appetites of insectivorous nestlings are prodigious. American observers place woodpeckers in the front rank of birds helpful to forestry, and cuckoos are useful because they are the only birds which devour hairy caterpillars freely. According to the records of German forest-ornithology individual blue and coal-tits have been observed to consume as many as fifteen hundred moths' eggs in a day, and the daily destruction of eggs and caterpillars by the bird population, as a whole, must run to astronomical

figures by the end of summer. Dr. W. E. Collinge has recorded that the remains of one hundred and thirty insects, including fifteen June chafers, were found in the stomach of a nightjar shot in early morning in the month of July. Larger birds also do valuable work and even the wood-pigeon, a vegetable feeder, has been seen to feed upon caterpillars of the oak-leaf roller moth. The food of birds of prey is chiefly animal but many of them do not disdain insects; all these, with the omnivorous crow family, including magpies and jays, help to counterbalance the undue increase of birds of other kinds, also of mice and voles.

Forests, and extensions of afforestation, affect animal life in several important aspects. Forestry necessitates the local extermination of rabbits, and thus interferes with a substantial part of the food-supply of certain other species, which must look elsewhere for their meat. New plantings tend to disturb and disperse birds previously in occupation of the ground and to replace them by insect-eaters, among which the warblers are usually well represented. Later when the plantations approach the pole stage a true forest bird population begins to form itself, a matter which, as we have seen, can be artificially assisted. From the beginning new plantations attract and shelter numerous animals and birds and in this perform a valuable service. The unhappy fact that a species, or Island race, can easily be exterminated if denied sanctuary, and, when finally killed out, is lost for all time, cannot be too widely realized. Our surviving fauna is not so representative that we can afford to lose any more native species. Afforestations may induce the osprey and honey-buzzard to come again as residents or breeders and, by immigrations of continental types, other lost birds may be restored to the avifauna of Great Britain through the agency of forest extension. But there is danger from across the narrow waters of the English Channel and North Sea, because insects can also travel long distances by air and there are insect pests in forests on the mainland of Europe which we certainly do not want to see established in British woodlands.

British forests do not boast of many reptiles. Frogs, toads, snakes, lizards, and newts complete the list, and with the lizards is included the slow-worm. All the native snakes—adder, grass-snake, and smooth-snake—may be encountered in sunny spots along woodland rides; the two latter are entirely harmless, but the adder, or viper, possesses poison fangs and may be the cause of inconvenience, if not worse. The smooth-snake is far from common, being con-

fined to the southern counties; naturalists believe it to be on the increase in the New Forest. Of all three, the most common is the grass-snake. It is foolish to kill snakes at sight as so frequently happens; their food includes mice and voles and all the other members of the reptilian family are busy insect-eaters.

Myriads of insects and an abundance of other invertebrates that occupy still lower places in the scale of life, complete the forest community. These are the flying, jumping, crawling, and burrowing creatures—butterflies, moths, flies, beetles, ants, spiders, snails, worms, slugs, *et hoc genus omne*. The rare purple emperor, one of the largest and most beautiful of the British butterflies, is a forest species and has its realm in the tree-tops, and most of the fritillaries are woodland species. Forest insects may be classified as hosts, parasites, and predators, some injurious and the cause of serious loss, but there are a great many that work for the good of the forest and the health of the forest crop.

Many humbler denizens share with the non-parasitic fungi, moulds, and bacteria, the labour of breaking down forest litter into humus to enrich the soil and also help, as cultivators, by constant burrowing and working. Insects are scavengers of the forest and are responsible, in no small degree, for maintaining the forest floor in a sanitary condition. Dragon flies, the hawks of the insect world, fierce as they look, are harmless to men and trees. Predators and parasites embrace species which prey on defoliators, bark-destroyers and wood-borers, and on the smaller fry which eat into, or suck the juices from leaves, seeds, twigs, and roots. The predators devour the eggs, caterpillars, and chrysalids of other insects, or catch and kill them in their mature stages, and give assistance of inestimable value in controlling unruly numbers of harmful species which, owing to an unlimited capacity to increase in favourable conditions, are able, sometimes, to assume devastating proportions. Loudon, in his comprehensive work on *British Trees and Shrubs*, illustrates the immensity of the insect population in forests by quoting the oak as host for no less than two thousand different species, those causing the various characteristic oak-galls, alone, being very numerous.

The marvel of it all is that this teeming, striving concentration of life should merge itself into an organic whole, and combine to produce trees, the largest and longest-lived of all living things. Each separate element contributes, in one way or another, to the commonwealth in which it works out its destiny, and each takes something from the common stock for its own needs.

Collectively, in healthy forest, the contributions are the greater; every member, however humble, serves the wants or limits the actions of others, and because these compensating influences are all the time at work, silviculture is able to prosper. But there comes a point at which systematic forestry joins issue with natural cause and effect and, to grow timber trees as a first consideration over all the other elements, and to keep the tree crop from harm throughout the appointed rotation, methods must be employed which cut across some of the fickle processes of numerical fluctuations of species. If left to herself, Nature knows no such ordered restrictions; too much of this or too little of that, temporary excesses or deficiencies in the make-up of the forest population, are brief phases in the loose and lavish general plan, if, indeed, plan it can be called, because, if unregulated, natural fluctuations may spell ruin in forests managed according to system where the object is to grow utilizable timber, of chosen species, within a given time. And, if reliance centres on a single kind of tree, the risks are intensified. Effective control depends in a great degree on the application of accumulated knowledge of the lives and functions of the plants and animals that a forest harbours, and on insight into their diverse activities. A self-contained record of natural history is not displayed more completely anywhere than in a wood—the book is open, and, word by word, its pages are being read and understood.

Chapter II

PERILS AND PESTS

And bay'd about with many enemies;
And some that smile have in their hearts, I fear,
Millions of mischiefs. SHAKESPEARE

FORESTS and forest trees enjoy no immunity from risks and dangers and the ills common to living things. Disaster lies in wait, at every turn, ready to take advantage of cracks in forest defences, no matter how jealous guardianship may be; one of the foremost duties implicit in woodland management is care for the health and safety of the trees and of the soil which supports them. Forest protection stands out among the important branches of silvicultural practice and busy minds search without cease for new and improved safeguards. Calamities arise from climatic and biological causes, or from mismanagement, greedy exploitation, carelessness, and human misdemeanour. Tempest and flood; frost, snow, and hail; insolation and drought, are the principal hazards in the first of these categories; in the second, the destructive agencies are animal or vegetative, chiefly fungoid, although, in given circumstances, herbaceous and other wild plants may be damaging. As to the acts of man himself, there seems to be no limit to the mischiefs due to human interference, either by deliberate intent, accident, or from thoughtlessness or sheer ignorance. Fire is an ever present threat. Purely mechanical influences are also injurious, and the damage suffered may extend to forest roads and other ancillary equipment of the forest as well as to the growing trees and soils.

Vagaries and violence of weather constitute major risks. Periodic gales sweep the country and uproot trees, thousands of which are thrown over from time to time by storms of wind; wide swathes being cut through thriving plantations and woods, and a welter of fallen and broken trees left, lying criss-cross, in the track of the storm. Wholesale windfall has occurred in recent years, particularly in Scotland and across northern England; veritable hurricanes occasionally blow, and the dreadful gale of November 1703, recorded by Addison in his eulogy of the great Marlborough's campaign, spent its main force over the British Islands; it is an instance of the wind risk in Great Britain at its worst. The destruction of timber wrought by this storm was enormous. Doctor Hunter, in his notes to the third edition of Evelyn's *Silva*, states

that 'a certain person set himself the task of numbering the trees that were torn up by the roots; but when he had proceeded through but a part of the county of Kent, he counted two-hundred and fifty thousand, when he relinquished the undertaking'. Throughout southern England elm trees are regularly uprooted by south-westerly gales, a circumstance which accounts, to a great extent, for the trivial value often placed on prime elm butts in these counties. Elm is a shallow rooter and so is not at all a stable tree, but high winds, especially when they occur in combination with rain-soaked soils, often prove too strong for deeper-rooting species to resist; sodden soils due to the neglect of forest drainage greatly aggravate the danger of windfall. Serious damage by wind is not always on a wholesale scale. Gaps or holes may be torn out of young pole woods by eddies of wind. Such holes are usually difficult propositions to mend; the tendency is for succeeding gales to extend the blown areas, a risk to which a forest is also exposed where severance fellings are made to facilitate exploitation, if these cuts are not wisely orientated. Trees within a plantation are not always securely anchored against unaccustomed wind pressures from all quarters, thus, breaks in the canopy of a wood may prove as vulnerable as breaches in a fortress wall. Apart from risks of wind-blow, the persistent easterly winds of spring-time dry out and kill a proportion of the newly planted trees in most years, and, if accompanied, as these droughts often are, by spells of bright sunshine, the desiccation is all the more rapid and dangerous.

A close connexion exists between storm and flood. Flood-water is always troublesome; water-logged soils soon become unhealthy and the effects of stagnant water on soil biology are not quickly repaired. Flooding with salt water is fatal to tree growth in general. Uncontrolled storm water is a powerful abrading agent, particularly where the vegetation has been disturbed as in forest clearings. Excessive run-off may result in serious losses of soil and ruinous damage to forest roads and drains. Whatever the lie of the land, ample provision must be made for run-off and outfall, and there should be no delay in making good repairable damage to water-courses caused by abnormal rainfall.

Frost destroys the new growth of tender species and is sometimes damaging to riper tissues. On the other side of the account, frosts help to keep the insect horde in check and hard frost is a useful sweetener and purifier of the soil. When the thermometer falls below zero work in the forest and nursery is hindered, but the

most important silvicultural aspect of the changeable British climate is the loss of growth in young plantations and forest nurseries due to alternate frost and thaw; late spring frosts destroy new foliage and kill back new season's tender shoots. All but two or three of the species extensively planted are frost-tender when first coming into leaf; with few exceptions, both native and introduced species are liable to be cut back year after year in frosty places. Newly flushed leaves and blossoms of mature trees may be destroyed; the frosts of the middle of May 1935, when temperatures below 25° Fahrenheit were common about the country, will long be remembered by foresters. Tall oaks and beeches were scorched to a height of 60 feet and more in places, as if by fire, and the damage extended all through the country from the south coast to the Highlands. If flower-buds and blossoms are nipped by frost the prospect of a successful seed year is ruined; spring frosts are responsible to no small extent for the seasonal failures of forest trees to bear satisfactory crops of seed. Frost is mechanical in its action. The expansion of moisture in the process of freezing ruptures and tears the delicate cells and membranes within the soft new growth, and thus interrupts the internal circulation of moisture within the stems. External lesions resulting from frost also afford favourable points of entry for disease. Prolonged hard frost may cause *frost crack* when, unable to withstand the pressure of freezing moisture within, the bark bursts with a report like a gun-shot, the cracks usually resulting in blemishes in the timber. The very remarkable 'silver thaw', or glazed frost, which occurred in the month of January 1940, shattered woodland and hedgerow trees over a wide arc of country stretching from Kent, through Wiltshire and Herefordshire, into North Wales. Although glazed frosts are not so infrequent across the English Channel and have been recorded in the New England States of America, no similar calamity on so widespread a scale has happened in Great Britain within living memory. A tremendous burden of ice congealed on twigs and branches, smashing and disfiguring tens of thousands of trees by its weight, the twigs bearing long cylinders of ice up to four inches in diameter in some cases. The full effects of this spectacular visitation upon the maimed trees will not entirely disappear for many years to come. Telegraph and telephone installations also suffered.

Frost-lift in the nurseries is a serious and, at all times, a costly problem. As the ground freezes the surface-layer is lifted, the

small shallow-rooted plants are forcibly dragged up with it as it rises, to be thrown out on the surface of the beds and left to die as the succeeding thaw enables the soil to subside. The usual method of protection against frost-lift is to cover the seed-beds with a screen made of laths, but the real remedy lies in improving the root-hold of the seedlings—a matter largely dependent on the humus content of the soil.

Provided species are well chosen in accord with their moisture-demanding qualities, a heavy normal rainfall is not necessarily a disadvantage, but soils must be kept in a properly drained and aerated state or complications follow, not to mention the increased probability of windfall. Thunder-storms are chiefly feared for the wash-outs they cause; lightning blasts individual trees and sometimes kills trees in groups but, in British forests, losses attributable to lightning are few and far between. Snow, as it melts, may be the cause of flooding. The principal trouble with snow, however, is that trees are not always able to support the dead weight of heavy falls. Soft, wet, clinging snow sometimes proves too heavy for stiff branching pines and hardwoods to withstand—even the sturdy oak is liable to injury. Crowns are broken or snapped off, branches are twisted or stripped from the stems, and heavy-topped, feebly rooted species may be overborne by the weight of snow. The period of greatest danger is towards the end of the winter season when the tree-branches are already heavy with sap. Hail-storms, happily very local as a rule, slash and maim young plantations in the growing season; an untimely hail-storm may ruin the year's chances of a seed crop in older hardwood forest by battering the blossoms.

All forest life depends upon the sun's warmth, as we know, yet over-exposure to direct rays may be highly injurious. The effects of continuous sunshine are trying to newly planted trees, the root-systems of which are not well enough established to be able to compensate transpiration; even larger trees occasionally flag and die when desiccation is prolonged. Sun-scorch may also affect the bark of an exposed tree trunk, interfering with the subsequent down-flow of elaborated sap beneath the scorched places and disfiguring the tree.

Animals of many kinds are active enemies. Of the vertebrate depredators, the rodent family stand first as culprits; deer and domestic animals bear a share of blame, but, as to birds, their good offices are, on the whole, decidedly of value in woodlands.

The most devastating animal pests to trees of all kinds are the myriads of insects which give rise to some of the most anxious and perplexing problems the forester is called upon to face.

All rodents are mischievous. The indulgence with which rabbits, rats, and mice are regarded is quite remarkable, even among people who have good cause to realize the vast amount of damage they inflict. Until the repression of these animals is made everybody's business, there is little hope of real improvement in the position: spasmodic campaigns, whether local or national in scale, make no lasting impression against the prolific powers of reproduction the rodents possess, and the fashion to harry their natural enemies at all times, with gun, trap, and poison, does not help. So far as rabbits are concerned, sentiment also comes into play, for it cannot be doubted that people in general like to see a few of them about the fields and woods. It is plain enough that in forestry rabbits are nothing less than a headache and a heartache. Full stocking, by natural regeneration, could be maintained in most types of woods if the young trees were not eaten off as fast as they appear. If there were no rabbits, the expense of wire-netting and of continuous warrening would be avoided. It may well be asked why we tolerate this extravagant pest. Hares are not so universally distributed, many localities, including some of the worst of the rabbit-infested districts, are comparatively free from them. But an odd hare or two of either of the British species is an expensive guest among young trees, and hares, like rabbits, can be an especial nuisance when there is snow on the ground and normal food-supplies are not readily available; drifting snow, lodging against plantation fences, also provides a convenient ramp by which entry can be gained, although it is true that no ordinary wire-netting fence is proof against the agile hare at any time of year.

Squirrels are bad foresters and their habits are not at all in keeping with their innocent and attractive appearance, delightful little beasts as they are, when encountered in their forest haunts. In plain truth squirrels, of any colour, are forest pests; they eat buds, shoots, and seeds, and gnaw bark, frequently girdling tree stems so that the tops die and the timber becomes distorted and crooked to the serious detriment of its value. Quantities of poles have been rendered useless for the telegraph and telephone services by the native red squirrel in Scottish pine-woods alone, and its numbers have to be controlled if a substantial part of the forester's effort is not to be brought to ruin. Shelter

15. *Pine Marten: A very rare British woodland species. Above, in summer coa*
below, in winter coat

Photos. by MISS FRANCES PI

16. *Roe Deer. No respecter of young plantations, but well able to hold its own as heretofore*

and an abundance of food soon result in numbers getting out of hand; now that the British marten has become so very rare the only effective form of natural control seems to be the spread of epidemic disease. The bad reputation of grey squirrels may be well deserved. As far as observation goes their behaviour in their new homes in British forests is not consistent. They are doing a lot of damage in some parts by stripping or gnawing the bark of sycamore, ash, beech, and other species and by eating shoots and seeds, but, in other woods, traces of injury have not been so noticeable. The most widespread form of injury is the tearing off of long strips and shreds of bark from sycamore poles, apparently to get at the sweet sap beneath; this type of forest sabotage always takes place in early summer when the sap is flowing. The inroads of grey squirrels in suburban gardens are quite another matter. This pest is one more case of a light-hearted introduction of a foreign species without first weighing the pros and cons; unfortunately this little animal continues to extend its range and, in spite of abuse and campaigns of extermination, hitherto rather more noisy than effective, it has probably come to stay.

Rats are seldom a forest problem, and dormice, except for the small amount of seed they consume, are, perhaps, the least harmful of the rodent family, but long-tailed field mice and voles are costly pests. Lush vegetation springing up on areas enclosed for planting affords food in plenty, all that is required, where mice and voles are present, to initiate a cycle of increase on a sharply rising curve. Young forest trees are girdled or gnawed through at ground level, and trees up to 6 feet or more in height are not safe from similar damage. Predatory carnivores, including weasels, hawks, and owls, are the best protection, although, when food-supplies fail, the plagues die down or disease sweeps the densely populated colonies.

Browsing animals are always a source of trouble. Deer of all species are inveterate browsers and eaters of mast; those carrying antlers, the stags and bucks, do further damage by using small, whippy trees as fraying stocks to help rid the annually recurring growth of horn from irritating shreds of velvet. It is an annoying habit that destroys many a promising sapling. Sheep and cattle are also browsers and are undesirable trespassers in young woods, making an additional nuisance of themselves by treading in and obstructing forest drains and breaking down fences. But of the domesticated and semi-domesticated forest animals, the worst offenders are the ponies which graze on the mountains of Central

and South Wales, on Exmoor and Dartmoor and in New Forest, possibly because their double sets of incisor teeth give them an advantage over the ruminants.

Badgers, woodland denizens of very ancient lineage, are troublesome only because of the determined way in which they demolish obstacles such as wire-netting set across their accustomed runs. Foxes are also harmless to trees but they do much mischief about the country-side, and if too plentiful are as great a nuisance to foresters as to everyone else concerned. Although fox populations require to be regulated with a heavy hand, part, at any rate, of the lamb-killing attributed to them has been proved to be the work of underfed, straying sheep-dogs. The wild cat, marten, and polecat, with stoats and weasels, all form part of nature's insurance against plagues of the 'small deer' of forest and field. The three first mentioned of these species are not numerous enough to be a general nuisance, but, so far as they are objectionable in other directions, the two last must be kept down even though, like the hedgehog on his nightly rounds, their activities are of no disadvantage to forestry. Moles are attracted to cultivated ground in nurseries and have a decidedly unhelpful trick of heaping earth on newly planted trees in the forest if small easily smothered transplants are set out on light land.

In the previous chapter reference has been made to the useful part played by wild birds in the forest, which far outweighs any harm of which a few species may be guilty. Woodpeckers, which bore into trees, though seldom into trees that are entirely sound and healthy, more than compensate for the damage they do by the quantities of bark-beetles and other insects they destroy. A few other species injure bark and wood, eat tree seeds, or live on shoots and buds as their staple food; wood-pigeons, for instance, interfere with the natural regeneration of oak and beech, and starling roosts are an abomination. Otherwise little fault can be found. Pheasants eat acorns greedily and capercailzie live chiefly on the buds and shoots of conifers, while a similar predilection for conifer buds is the worst that can be said of blackgame, troublesome though they may be in young pine plantations.

Nature's 'balance' in a forest is in no respect more vital than among the innumerable varieties of insects that live out their life-cycles in the woods. Forest insects are legion and many are harmful. A slight improvement in the conditions which suit them, that is a favourable spell of weather and plentiful food and

breeding-places, is all that is needed to cause any of these pests to break bounds, and, by their incredible capacity to increase and multiply, to become dangerous plagues. So prolific are they when conditions are to their liking that no forest trees are entirely free from danger. Great tracts of forest have been devastated by insect hosts; many, but not all, of the species responsible for wholesale damage in continental woods are present in Great Britain and some kinds are active, but, in general, predators and diseases keep a constant check and the uncertainty of our island climate is another safeguard. In all circumstances, there is no better defence at the forester's disposal than to follow the dictates of good silviculture and maintain a healthy stock of trees. Insects do direct injury by eating the foliage, boring and biting into the bark, wood, roots, and seeds, destroying buds and shoots, and causing abnormal growths; indirect damage also results from exposure of the sapwood to infection and from the general lowering of resistance to disease which follows persistent insect attack.

Woodland butterflies—fritillaries, tortoiseshells, whites, blues, and perhaps, on rare occasions, the purple emperor—are as harmless as they are beautiful. The forest-dwelling moths also include many that do no harm, but the activities of others are highly injurious, all the more so because of the prodigious numbers in which they occur. The defoliators, larvae of the oak-leaf roller, winter and vapourer moths, strip the foliage from oak and other broad-leaved trees in early summer. Shoot and bud-boring moths attack many species, and the work of the pine shoot tortrix, causing 'post-horn' and other deformities, is all too familiar among Scots pines. Some of the forking to which young ash trees are prone is also the work of a bud moth. Caterpillars feed upon and destroy all parts of trees from the roots upwards, and those of the goat and leopard moths bore deeply into the wood of broad-leaved species. Conifer plantations in Great Britain have, so far, escaped serious visitations of the nun and looper moths which occasionally assume epidemic proportions on the Continent, where many square miles of forest have been ruined by their voracious appetites.

An immense variety of other winged insects of every conceivable size and form make the woods their homes. 'Clegs', midges, and biting and stinging flies in general are a pest to forest workers and, for the rest, innumerable species make up a mixed bag of useful, harmful, and entirely innocuous varieties. Foliage-eating larvae of saw-flies, especially of the pine saw-fly, which occur in writhing,

grey masses on pine branches, do extensive but hardly ever fatal damage. Other flies, including the leaf-cutting bee, destroy or disfigure the leafage, and, from the grubs of the formidable-looking, but stingless, wood-wasps, that bore into the tree stems, and the tiny, gall-producing *cynips*, to the predatory flies that devour other forms of insect life, all buzz, dart, or crawl busily about their business throughout the summer season, while their grubs are by no means altogether idle at other times of year. A small fly (*megastigmus*) lays its eggs in Douglas fir cones and destroys the germ of the seed and must be counted, with others, among the enemies of natural regeneration. But for the attentions of other insects, and birds, such as titmice and the goldcrest, the extraordinary fecundity of the aphids would alone constitute a serious menace; none is desirable as a member of the forest community, and one species of aphis appears to have rendered it hopeless to continue the cultivation of the common silver fir in our woods.

Beetles, and their long-snouted congeners, the weevils, are, in part, a troublesome tribe, excluding, of course, the feeders on animal and vegetable refuse of the forest, which are excellent scavengers, and others, ladybirds and tiger beetles for example, which prey on other insects. Bark beetles and weevils do inestimable harm in pine and other conifer plantations. These shoot-boring and bark-gnawing insects include some of the most dangerous pests in British forests. They breed under the bark of sickly trees and in the stumps and branch-wood left on the ground after felling, and where their grubs are found it is never wise to replant until the infestation subsides. As with certain other pests, pine beetles and weevils are controllable by proper silvicultural management and by trapping. Several broad-leaved trees have their own particular bark beetles which pierce and riddle the bark with their bore-holes, tracing their breeding galleries beneath in characteristic patterns which have earned for them the description of 'engraver' beetles; the work of the ash bark beetle is one that is commonly seen. There are also secondary effects to bark beetles' activities, and it is now recognized that the species infesting the elm is an active agent in spreading the disease that is now affecting so many of the elm trees about the country. The larger chafer beetles are yet another problem. The appetites of their larvae, which live underground for one to four years according to species, play havoc with nursery stocks. Rootlets are often completely

stripped and plants die or are enfeebled. Summer fallowing is the best of the known remedies but no counter-measure yet discovered is entirely successful; fortunately the mature insects do not defoliate hardwood forest with us as they sometimes do abroad.

Many of the intricate problems concerning forest insects, their control and economic importance, are yet unsolved. Some kinds require a second tree or plant as an alternative host to enable them to complete their complicated life-cycles; much still remains to be discovered and worked out before complete life-histories and powers for good or evil are fully known. It is only then that rational protective measures can be devised. Trees weakened by insect attacks fall victim all the more easily to other ills, and the work of one species often makes it easier for another to follow on in the fell work, or for the spores of parasitic fungi to gain access through the protective armour of the bark and give the *coup de grâce* in affected stands.

Forest trees are not without enemies in the vegetable world. Young plantings suffer much from herbaceous weeds and fern unless artificially assisted by weeding. Intrusive trees, shrubs, and coppice shoots compete for light, moisture, and soil nutrients; by swaying in the wind they also tend to whip and bruise the tender leaders of cultivated trees. Briar and bramble are injurious and where honeysuckle obtains a stranglehold the damage permanently distorts if it is not actually fatal; even the soft annual spirals of bryony occasionally constrict young stems. Ivy is not a parasite. It is harmful only by reason of its weight when allowed to spread into the live crown of the tree up which it climbs. Mistletoe, a true parasite, is not sufficiently common to be a pest.

The most insidious and deadly foes of the plant kind are found among the fungi, which are spread by microscopic spores; the *rhizomorphs* and *mycelia* or fungal threads penetrate into the tissues of the trees and cripple or kill outright. Timbers are rotted, stained, and rendered unmarketable, although 'brown' oak, greatly prized by cabinet-makers, is an exception, its enhanced value being due to fungus attack. Parasitic fungi of one sort and another are capable of destroying all parts of trees. Mildews are responsible for the damping off of seedlings, and the mould frequently to be observed on oak leaves requires little assistance from other enemies to inflict serious damage. Pests, not of necessity fatal in themselves, can be deadly in combination with other foes.

To the perils Nature imposes on forest trees must be added

numerous shortcomings of mankind. The dismal neighbourhood of colliery workings and manufacturing districts—the environs of Widnes and Swansea are glaring examples—gives warning of what may follow when commercial enterprise plants itself in rural surroundings. Very few forest trees tolerate smoke and fumes kindly. Well-sinking and pumping and, indeed, injudicious surface draining and interference with water-courses, affect the level of the water-table over wide districts and inevitably react upon the health of trees; underground mining is also disturbing, and the winning of surface minerals is directly destructive in woodland areas.

Silviculture may also be at fault. Errors in the choice of species are fundamental and are brought about by failure to assess the true possibilities of sites and soils. Neglect to maintain soil fertility and to perform essential forestry operations like weedings, thinnings, and rabbit-killing are, with disorderly exploitation, some of the sins against the Forest Code, tending to predispose woodland to risks and ills. A healthy tree in a healthy forest is its own best protection from natural enemies, but not from actions of which man is capable. No unauthorized persons should be allowed to carry edged tools in a wood; among the injuries, deliberate or accidental, arising from human trespass are illegal cutting and slashing, theft, leaving open of gates and so giving access to domestic animals, damage to fences or simple foolishness, as in one of England's most ancient forests, some years ago, when local humour took the form of twisting and tying the supple leaders of Douglas firs and beeches into knots and bows.

But, of all the devastations that may befall a forest, none is more utterly ruthless and final than fire. The menace of fire is an ever present dread in the hearts of foresters and the gravity of this dire hazard, together with the problems of protecting woodland from the fire risk which recurs regularly according to season, are matters of such manifest importance as to warrant a chapter to themselves.

FIRE!

Fire and people do in this agree,
They are both good servants, both ill masters be. GREVILLE

FIRE, the arch-enemy of forests, is the most implacably remorseless of all forest destroyers. Millions of acres of the world's timber resources have been burned and desolated, and waste by fire continues in spite of elaborate precautionary measures which become more expensively organized in each successive year. It is certain that the alert and scientifically equipped forest fire guard services succeed in reducing the appalling loss, but forest fires continue to occur with lamentable regularity, and the probability is that this grave hazard will never entirely be overcome. Limitation of danger lies in the hands of all who resort to woodlands, whether on duty or on pleasure bent, for the risk depends first and foremost on the care people take when they strike a match among the trees. Controlled fire, employed with judgement and proper precaution, is a useful aid when there is litter to clear away, or when preparing certain types of land for planting; fire can be employed also as a counter-measure against itself, but uncontrolled fire in a forest is merciless. Destruction has occurred on a stupendous scale in North America in the past half-dozen decades alone, yet Canada and the United States maintain the most efficient and well-equipped forest fire services ever organized in the interests of forest protection. Fire patrols are always on the look-out, and fire-fighting, supported by every device experience and science can suggest, has become a highly specialized art. All forest-owning nations are concerned to minimize this dreadful threat to the accumulated wealth of their woods and to the lives and homes of woodland dwellers.

As befits the more modest extent of our woodland, forest fires occur on a smaller scale in Great Britain. Nevertheless, they are all too numerous and, in the aggregate, represent a serious cumulative loss. Young plantations are especially vulnerable, and most of our forestry in the coming half-century will be concerned with the formation of new woods. Great forest fires are reported almost every year from other parts of the world. They flare up from time to time in the Mediterranean regions of France and other parts of Europe, while the forest-burning proclivities of natives of

Africa, India, and Burma are well known. Spectacular forest fires have swept the North American timber lands from the time of the Pilgrim Fathers, causing untold destruction. To the early settlers, fire was the handiest means of clearing primeval forest for cultivation and, to all appearances, timber was then in inexhaustible supply. The scars of fires, recorded deep in the wood of surviving forest giants, tell also of earlier burnings in days long before the first white settlers arrived in the New World. Canada has suffered severely. One of the greatest forest fires on record started in the Miramichi Valley in 1825, and swept over some 3 million acres of New Brunswick. This holocaust cost 160 human lives. Other fearful fires have raged in the Canadian forests from British Columbia to Quebec. In 1853 the Pontiac fire destroyed over 1½ million acres of timber, and since then no lengthy period has been free from devastating conflagrations. In the United States the destruction of forest by fire has been quite inconceivable. Over 1¼ million acres of timber trees were lost and no less than 1,500 persons were burnt to death in the Peshtigo outbreak in Wisconsin, in 1910; yet another blaze, of 2 million acres, at Cloquet, Minnesota, in 1918, killed more than 400 people and totally destroyed a township of 12,000 inhabitants. Big fires occurred in Oregon and California in 1932 and the following year, while a relatively unimportant fire in the Blackwater country of Wyoming, four years later, cost the fire-fighters fifteen lives from heat-blast. Australian forests have not escaped the wrath of the red fiend. In 1937 many square miles of timber were lost in New South Wales and Victoria. It is estimated that 71 lives and 2,000 million board feet of eucalyptus were lost. Again, early in 1943, a great fire ranged across a wide tract of wooded country in Victoria. Nor have forests planted in South Africa and New Zealand gone scot-free. The story of horrific destruction is the same wherever forests exist; in spite of warning and precaution the tale goes on.

It is not to be wondered at that Forest Services throughout the world dread this terrible scourge and make strenuous efforts to protect their forests. The speed with which flames can travel over forested land is amazing and the notion of wild-fire might just as easily have had its origin in the spread of fire through a forest as in the offensive combustible known to the Greeks of old. Fire in woodland is an awesome spectacle. It sweeps through the trees in a terrifying wall of flame, giving off dense, acrid smoke, and burning up everything in its path. All that remains is a charred

desolation, over which all animal and vegetable life is blackened and dead. The patient work of years, and in natural forest the growth, maybe, of centuries, is wiped out relentlessly and utterly in a few hours.

Foresters recognize three well-defined types of forest fires. Those confined to surface vegetation are chiefly destructive to young plantations up to the thicket stage, and are known as *Ground Fires*. These fires are a danger also where the timber trees are older because there is always risk that the blaze may reach the upper branches and foliage and so start a crown fire. When fire envelops the tree-tops in high forest it is termed a *Crown Fire*: this type is the most destructive of all and the most terrifying and dangerous to combat. The third kind of fire encountered in forests is *Underground Fire*. Humus and peaty soils, when very dry, may be set on fire and then smoulder, often burning below ground for considerable distances, to flare up again at surface level in places well away from the point of origin. Root systems are consumed and trees die. Each of these types occurs in British woodlands and experience shows in this country, as elsewhere, that risks are closely related to the state of the weather. Both 1941 and 1942 were dry years, and all too great a total acreage of plantations was lost. However, contrary to what might have been expected, losses due to enemy incendiaries proved unimportant. As usual blame is attributable chiefly to public heedlessness.

Danger is rife in periods of sunshine and wind, or after hard frost, all of which, singly or in combination, speedily render ground vegetation dry and inflammable. Plantations of all species are equally at risk, but the danger is greatest where the crop is composed of the resinous conifers. Naturally, in such a climate as the British, outbreaks vary in frequency. A dry winter or spring, with frosts, easterly winds, and spells of sunshine, create conditions which may be continuous from the turn of the year until the new season's green shoots appear. A dry, hot summer and autumn prolong the period of anxiety; it is a never-to-be-forgotten fact that there are not many months in the average year in which a forest will not burn. Even after rain a few hours' sun or wind render conditions dangerous, and the harassed forester, labouring under the burden of a threat he can seldom ignore, finds a thoroughly wet and cloudy season more to his taste than a dry one.

An ardent fire seldom fails to kill growing trees and may render their timbers useless for salvage. At the best only a proportion of

the crop dies, but vigour is impaired and both quality and production suffer. Damage also manifests itself in other ways. Singed trees are rendered more vulnerable to disease and insect attack; partially burned pine stems attract beetles and weevils, affording breeding-places greatly to the liking of these insects. A fire through a young plantation nearly always destroys the trees beyond hope of recovery, except that some broad-leaved species are able to shoot again from ground level if the roots are not severely scorched; oak and ash, for instance, sometimes make acceptable growth by such rough coppicing; of all our trees, the birch is as difficult as any to kill, root and branch, in a forest fire.

Young conifers hardly ever survive even a moderate scorching. Thick-barked conifers in later stages of growth withstand considerable heat from ground fires, and old broad-leaved stands are in still less danger; indeed it is not easy to start a crown fire in hardwood forest in our climate. It is a different matter when fire reaches the canopy of a conifer wood: wholesale destruction then follows almost as a matter of course.

Forest fires are as fatal to animal as to vegetable life; very few wild creatures within the range of fire escape death either by burning or suffocation; birds unfortunate enough to get their wing feathers singed are doomed. Soil fertility, too, is affected where the humus layer burns; surface conditions deteriorate and radical changes in vegetation frequently follow a severe burning. The change is, indeed, generally for the worse, as may be seen on upland sheep grazings and grouse-moors, where heather burning has been overdone. Inferior species put in an appearance, such as *Scirpus* and cross-leaved heather, and bear witness to the reduced status of the soil.

No one who works or walks in fields or woods ought to forget for a single moment that danger is not confined to sunny weather. Herbage may be as dry as tinder under cloudy skies or in cold, biting wind and, when soaked with rain or dew and safe at the moment, grasses and ferns can become quite ready to ignite a few hours later. No forest plant or tree exists in Great Britain that will not burn readily at one season or another. Heather and gorse blaze furiously at any time of year; the only time that weed-growth is relatively uninflammable is when the spring and summer growth is green and sappy. The blue moor-grass (*Molinia caerulea*) is a particularly dangerous type of vegetation. It covers many thousands of acres of 'white' moorland, and, when alight, the papery leaves are

carried forward by the wind, leap-frogging ahead to extend the burning zone. There is good reason for calling this grass the 'blowing bent', as it is termed in the North Country.

Spontaneous outbreak of fire is not impossible in woodland but is an extremely rare phenomenon. A bit of broken glass can in theory, and possibly in fact, be placed so as to act as a burning-glass, although few, if any, forest fires have been traced directly to such cause. Experiments made in France, some years ago, with pieces of glass of all sizes, shapes and colours, dropped casually under favourable conditions for producing a blaze, all conspicuously failed to give positive results. Lightning occasionally sets fire to a forest, but the risk is negligible in Great Britain by comparison with parts of America and South Africa where electrical disturbances are more common and much more severe. In this country, forest and moorland fires are chiefly 'accidental', many being traceable to the wilfulness and stupidity of individuals. Outbreaks are commonly caused by:

Sparks emitted by railway and road engines.
Moor burning by farmers and gamekeepers.
Picnic and other fires lighted by irresponsible persons.
Burning of rubbish by forest workers.
Smokers, i.e. the dropping of *lighted* matches, burning tobacco, and cigarette ends.
Gob fires from colliery tips.

Inconsiderate behaviour has much to answer for. The itch to light a fire, 'the prompting of the incendiary who lives in the heart of every man', is the all too common cause of these disasters. What is not realized until too late is how easy it is for fire to get out of control. The remedy lies in popular education; only by spreading knowledge of the written and unwritten law of the countryside can this hideous danger be overcome. Malicious burning, with intent to do damage in woods, is happily rare, and, very rightly, misdemeanour of this sort is heavily punishable; a maximum penalty of fourteen years' penal servitude is ordained by the Larceny Act of 1861. What is not generally known is that where malice is not in question, persons who deliberately light fires in the neighbourhood of woods without taking due precaution do not escape civil liability for damage done. The doctrine of law in these cases is that action dangerous to other people's property is done at the peril of the doer. It is also illegal to light a fire on public

open spaces, and fire-lighting may also be prohibited by local by-laws. Warning notices are displayed prominently in all State forests and, in Wales, some are printed in the language of the Principality. Warnings are repeated in the newspapers and by broadcasting in seasons of hazard, but until people realize how necessary it is to be cautious with fire out of doors it is to be feared that wasteful destruction will continue in our woods. Road-sides and railway lines are often bad danger spots.

There are proper times and places in which to make camp and picnic fires, and proper ways of making them and putting them out again. Many picnickers may think a primus stove safe, but it is not. It can be overturned and ought not to be used near inflammable vegetation. Prevention is better than cure, but the simple rules and methods for fighting a heath or forest fire in its early stages require also to be widely known; there is no time for hesitation when herbage is alight, because, if the blaze is not tackled with resolution straight away, it quickly spreads beyond control. When this happens the only thing to do is to summon help with the least possible delay. Shakespeare, as usual, has the *mot juste*:

> A little fire is quickly trodden out,
> Which, being suffered, rivers cannot quench.

National Forest Parks have been thrown open to the public as a help towards wider knowledge of what forestry stands for and the risks to which forests are exposed. To know woodland intimately is to realize that it is a valuable and vulnerable property.

The conventional system of compartments in which a forest is laid out for management purposes is also an aid to protection from fire by providing breaks in the canopy, means of access, and points from which flames can be attacked. The ways of fire among trees are queer and unpredictable; a mere footpath sometimes stays its course when, as often as not, a wide and carefully prepared fire trace will fail to perform its function. The direction and force of the wind are important considerations, the volume of hot air rising from the blaze often causes disconcerting variations; the sudden ascent of hot air is also apt to raise a local breeze on the calmest of days. The stronger the wind the fiercer the flames driven before it. Faith is often reposed in belts of trees of species assumed to be resistant to fire, but as a matter of experience, there is no such thing as a fireproof tree. Broad-leaved trees are usually planted in 'fire belts' and may be useful as spark arresters if no

more; Japanese larch is proving effective as a fire stop in some circumstances, if planted in belts, though, in others, it fails and succumbs to burning like any other tree.

Controlled fire is employed to clear the surface growth from fire traces, in counter-firing, and, as a measure of precaution, French foresters make use of the *petit feu*, to get rid of inflammable material from the forest floor. What they do is to run a quick fire over the ground to burn off dead weeds and rubbish. Great judgement is necessary to make sure that the heat generated is not enough to injure the tree crop. The method is useless in very young plantations and, on the whole, is too risky to introduce into British forestry practice.

To protect forests from fire and fight fires when they break out, plans must be well thought out beforehand and all possible eventualities provided for as far as it is possible to foresee them. Proper equipment and experienced personnel and manpower are first essentials. Each forester-in-charge should have his *fire-plan*, on which is marked the points of danger, together with the approaches to all parts of the forest, and the location of water supplies, tools, pumps, and other apparatus. Look-outs and patrols are posted night and day in danger seasons and observation towers erected at points of vantage, each connected by telephone with the local control headquarters, have made their appearance in a number of British forests. The greater area of forest in other countries necessitates still broader methods: in North America aeroplane patrol and wireless communication are routine measures.

When a fire is located, the limitation of damage becomes firstly a question of speed and secondly of the weight of attack. A few men with light tools concentrated on the spot within the shortest possible time can often save the situation, but the arrival of stronger forces and heavier equipment must not be delayed. Ground fires are put out by beating with green branches, fire beaters, wet sacks, and long-handled shovels, or with the help of water by means of knapsack, hand, and power pumps. Deliberate counter-firing, or burning a strip of forest in the face of the advancing fire to break the continuity, is a more heroic resort; it is a highly skilled operation which should not be attempted under any but experienced guidance. A usual tactic is to attack the flames along the flanks of the fire and endeavour to bring them to a narrow front, or to divert the danger to a less valuable quarter of the forest. A flank attack also avoids the worst effects of heat and the suffocating smoke. To

arrest the course of a crown fire either a widely diffused spray or, alternatively, powerfully propelled jets of water are needed according to circumstances, or the continuity of the canopy must be broken widely and rapidly enough to prevent the flames leaping the gap. A natural break in the forest is often the only effective stop but counter-firing, or counter-felling, if carried out quickly, sometimes serves the turn, the object being to bring the fire to a point at which it subsides for want of further fuel. Crown fires are not yet the major threat in the new British forests; the danger exists, but, in our damp climate, may not become the desperate menace it is in other lands. Fire in the soil is contained by digging a trench around the burning area; short of saturating the ground with water to the necessary depth this is the only sure way to prevent a peat fire from spreading.

Chemical extinguishers have not proved of much value hitherto but the use of water is coming more and more into favour; light pumps, propelling a jet or spray, for use according to circumstances, are readily portable and very efficient, both in fire-fighting and for damping down the smouldering ruin left behind when the fire has passed. A comparatively small quantity of water is effective if properly applied; the usual difficulty is to maintain water-supply, and streams, ponds, or artificial reservoirs must be at hand; tanks mounted on motor lorries help to solve this problem. But let it not be forgotten that when fire first breaks out, half a dozen men moving quickly with beaters and light knapsack pumps are worth several times their number struggling along at slower pace with heavier appliances, however valuable power pumps may be if the advance guard fails to hold the blaze. Anxiety is not done with when the primary conflagration is brought to an end. Charred areas must be patrolled, sometimes for days and nights on end, because smouldering stumps and humus have an uncanny way of flaring up again in unsuspected places, scattering blazing embers and starting new fires; changes in the direction and force of the wind help to produce these secondary outbreaks.

Fighting forest fires is a dangerous business. There is risk to life and limb from burns and suffocation, and, apart from direct burning, heat-blast alone has proved sufficiently intense to cause fatalities. There is not much freedom of movement in a closely planted wood: to be caught in a blazing thicket is an extremely unpleasant predicament threatening certain severe injury, if not death. Many men have lost their lives while defending forests from

fire, but, up to now, only one fatal accident has happened in the State Forests of Great Britain. All the same, forest workers have been in peril and have been injured on numerous occasions; not infrequently, men have been obliged to take refuge in ditches and watercourses to allow the flames to pass over them. Burns are frequent, and clothing and equipment suffer heavily. Fire-fighting is tiring, thirsty work even when relays of men can be organized; food and drink are very necessary, and tea, and other hot drinks, are better than cold beverages.

It is worth while to reflect that fires in woodlands are mostly preventable and that what is at stake, at the present juncture, has a value to the nation in years' growth additional to its value in money. Practical points to remember are that there are not many days in the average year in which a plantation will not burn and that fire, once alight, may so quickly gain mastery. When flames or smoke are seen in or near woodland, or are detected by the smell of burning, go to the spot and put the fire out if you can. If it has already taken too strong a hold, raise immediate alarm and obtain help; the time factor is enormously important. Never light a fire where there is the slightest risk, and do not forget that in and about a forest there are few places where fire can do no harm. Never throw away a lighted match, and grind out the spark of every cigarette-end heavily beneath the heel. As a last admonition, never lose sight of the fact that very nearly every forest fire is bred of carelessness.

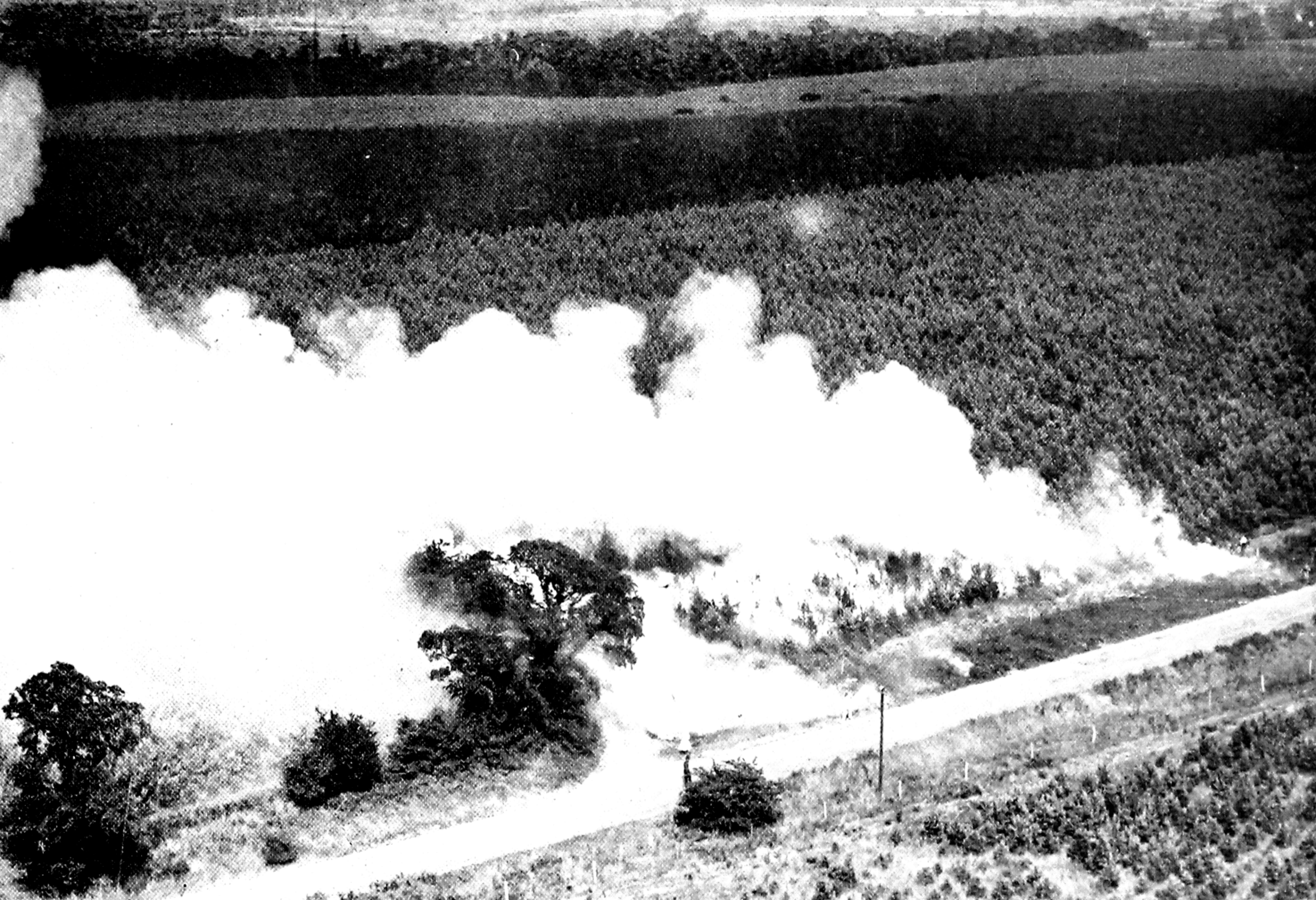
Chapter 13

FORESTRY AS A CAREER

I keep six honest serving men,
(They taught me all I knew),
Their names are What and Why and When,
And How and Where and Who. KIPLING

THE business of forestry, and its background of science and research, necessitate specialized training for all who wish to make the planting and management of woods their life's work. Forestry, as a profession, calls for a very considerable breadth of technical and general knowledge, the accepted foundations of which lie in a sound preliminary education, including more than a nodding acquaintance with the sciences, followed by a suitably directed course of study in the theory and practice of the art of growing and utilizing forest trees. Foresters are husbandmen, business men, and, to the degree imposed by the circumstances in which they work, scientists also; they grow and harvest crops of trees, and rub shoulders with their fellow men in affairs and in the market-places, furthermore they must keep pace with discovery and experiment so far as research influences production from Mother Earth and the cultivation of tree crops. To know and understand the land and its soils in their responses to all the four seasons is a first essential; of necessity, foresters must cultivate that indefinable awareness of the characteristics of land, which has been called 'land sense', a faculty that is born in some men and can be acquired in great measure by others. This is an especial need as affecting forestry in Great Britain, where forests have now to be created *ab initio* amid an extraordinary variety of conditions, and where the uses to which land is put are hedged about by law and custom to a degree entirely foreign to lands of virgin forests, or in countries where forestry has firmly established its Code. It is necessary, also, to know about the living things of the country-side, not only the land and the trees, because, as ecology is teaching, the reactions of living plants and wild creatures, one upon the other, influence the course of the entire animal and vegetable world. As with all husbandry, forestry is of the land.

To those who would direct and supervise the management of forests there is a considerably wider field than formerly. For many years the famous Indian Forest Service, not so long ago the only



18. *A Forestry Commission Fire Watcher's Tower, Thetford Chase*

organized forest service of which our Empire could boast, afforded almost the only opening for a career as a forest officer, but, as the world problem of timber supply assumed clearer proportions, forest services were inaugurated in the Dominions and Colonies and, as a final awakening, also at Home. In view of the overseas demands for men with a forestry training it is not altogether surprising that instruction at the University Forestry Schools has hitherto been preponderantly on the side of tropical and sub-tropical silviculture. It is only since a technique suited to the insular conditions of the British Islands has seriously begun to be built up, and the occupational possibilities of forestry at home became more fully realized in academic circles, that serious attention has begun to be paid to the forms of teaching required to fit candidates for work in the forests and woods of our own country. For the most part the numbers of would-be forest officers who qualified in the between-wars interval have been about equal to demands for their services, but it has happened, owing to irregularity in rates of recruitment, unavoidable when 'economy' axes swing, that in some years more men have graduated than there were posts available. The fact that exceedingly few university trained men have been successful in finding suitable employment in private forestry in Great Britain has accentuated the difficulty at these periods; moreover, recruitment of home-trained forest officers for the Indian Service ceased in 1938. The unfortunate result of this, and of imposed parsimonies, is that the forest services of the Empire are short of officers with experience in the field, to the full complement necessary to launch the foreshadowed expansions of forestry activity. There is also the point that the value of experience is related in great measure to the environment in which it is gained. The remedy is, of course, properly to train more young men, and all forest authorities are agreed that this must be done.

New entrants to the forestry services, engaged as probationary forest officers, are required to possess a University degree in forestry, but it is fitting here to mention that a forestry degree or diploma is no more than the first of the steps that go to the making of a forest officer; the job has still to be learnt, indeed, a man who takes up forestry as a career must be prepared to add to his experience and educational equipment throughout his working life; he cannot afford to rest on his oars in this regard. There is always something new to be discovered in woods and plantations; a true forester remains a student all his days.

We may ask what manner of man makes a good forest officer. It is a searching question because the answer lies entirely in the individual himself. Integrity, intelligence, good health, and sympathy with rural affairs, are the fundamentals. And these are not all. Qualities of resourcefulness, assiduity, and orderliness; capacity for leadership; the faculty of clear expression; and a quick observant eye, with a lively curiosity into whys and wherefores, are all important; if these characteristics are leavened with modest optimism, courtesy, and a sense of humour, life and work are made so much the easier. The uplift of a strong sense of duty, and the ability and will loyally to co-operate, are also essential parts of a forest officer's build-up. Forestry is not a one-man job, its detail and implications are too complicated for individualism, although there is nothing in it to discourage or stultify individual initiative in the common cause. Lastly, if the young enthusiast for a forestry career is to draw the best from the active and engrossing life opening to him, he should take interest in the things that live and grow round about him, and in the sports and pastimes the countryside offers both indoors and out. The duties of a forest officer are exacting, often arduous, and because they may lie far from amenities so many people now take for granted, the work is often solitary. Young forest officers may frequently be thrown upon their own resources for relaxation.

It has been said that the cultivation of trees in forests gives a sense of power over nature greater, perhaps, than any other form of husbandry. The very fact that the largest of living organisms can be controlled, and their growth and form made to respond to the act of man throughout a life-span exceeding that of all other living things on earth, is enough to instil a feeling of ascendancy, dear to the hearts of most mortals. There is more of the eternal in a forest than in most things, and so, because of the surroundings in which he works, the forester is apt to develop philosophical comforts of his own. With all this, however, he does not escape the office stool: records, accounts, reports, correspondence, and maps make inevitable calls on his time and he should be ready with his pen and slide rule on occasion; attempt to keep reasonable pace with the flood of technical forestry literature alone leaves room for few idle moments indoors.

Schools of Forestry are established in the Universities of Oxford, Edinburgh, Aberdeen, and the University College of North Wales, at Bangor. In general, the courses of study occupy three years and

lead to a degree in forestry. Courses of instruction vary slightly in structure and detail at the different Universities, but all are comprehensive, and the curriculum at Aberdeen may be taken as representative:

First Year:

Natural Philosophy (Physics).
Botany.
Chemistry.
Zoology.

Second Year:

Forest Chemistry.
Silviculture.
Forest Mensuration.
Meteorology.
Forest Botany.
Geology.
Forest Protection.
Plant Physiology.
Surveying.

Third Year:

Silviculture.
Forest Management and Utilization.
Forest Engineering.
Forest Policy.
Forest Zoology.

Practical instruction is given in the Summer vacation in the first year; in the Easter and Summer vacations in the second year; and in the Easter vacation in the third year. The final Summer term is devoted to the practical aspects of Silviculture and Forest Management, which in normal times takes the form of a tour of Continental forests.

To cope with the needed improvement in the facilities for forestry education, the Imperial Forestry Institute was set up at Oxford, in 1925, as a centre for post-graduate study and research. A reconstitution was made in 1939, and the functions of the Institute now include the teaching of forestry from the beginning to selected graduates in other subjects. This course extends to two years, and

a diploma in forestry is awarded to successful students. Refresher courses are also open to serving members and probationers of the Government Forest Services who are graduates from the Schools of Forestry. With the termination of the war the Universities intend to revise and extend their courses so far as necessary to bring them fully into line with up-to-date practice. Further provision for higher forestry education is also to be arranged.[1] Those who would inquire can obtain all relative particulars of the University courses in forestry from the Faculties of Forestry in the four Universities. There is no limit of age for admission, but it should be noted that the subsequent selection of graduates for the Government Forest Services is subject to age limits in every case.

Service conditions and scales of pay differ in the various Services, the pre-war grades and substantive scales of pay in the Home Service under the Forestry Commission being as follows:

District Officers (age of entry 21–30):	
Junior Grade	£275—18—£525
Senior Grade	£525—25—£650
Divisional Officers . . .	£750—30—£1,000

War bonus and allowances have been added during the war.

Promotions to the limited number of higher administrative positions depend upon ability and experience, but there are certain posts open to graduates with attainments in particular branches, as plant pathologists, entomologists, ecologists, forest engineers, and for such-like specialist work. All established forest officer appointments in the Government Forest Services are pensionable.

What has been said about the forest officer classes is true in essence regarding subordinate supervisory grades—the foresters and foremen who constitute the backbone of a forest service, and whose training, although differing in scope from the higher levels of forestry education, is none the less thorough. As a preliminary, education up to secondary school standards is desirable. To avoid the possibility of disillusionment before it is too late, practical working experience in the forest has been wisely insisted on before a young man finally makes up his mind to become a forester, but men who respond to the call of the forest, and who undergo the necessary training, may take service either on private estates or under the Forestry Commission. The work of rehabilitation in wood-

[1] In 1944, Oxford University promulgated a Statute raising the Forestry Course to the status of an Honours Course in the University.

lands in private ownership and the necessary expansion of afforestation by the State, give promise of opportunities for young men; it may be noted that, in the State Service, the higher ranks are not barred to men of the right stamp and character who fit themselves for responsibility. Nor is the question of training at all an insuperable one. Candidates between the ages of nineteen and twenty-five years, who are British subjects and who have spent a year in forest employment, are eligible for selection for entry to one of the Forestry Commission's Forest Apprentices' Schools. Two of these Schools have been open for many years, one in the Forest of Dean, in Gloucestershire, and one at Benmore, in Argyll. These foresters' courses extend over two years. There are no fees and board and lodging is free, with a weekly cash allowance to each forest apprentice, a bonus at the end of the first year and again at the satisfactory termination of the course. The regulations are simple, and particulars can be obtained from H.M. Forestry Commissioners. The courses combine practice with theory, candidates who satisfy the examiners are awarded a forester's certificate at the end of their second year, thus becoming qualified for supervisory posts in the woods. When the war is over it is expected that more forest apprentices' schools will be opened on the model of the Dean and Benmore.

The course of instruction covers the complete round of practical work in the forest and forest nursery, including the growing of nursery stock; preparation of ground; planting; tending plantations, felling and measurement; surveying and estate work. The syllabus for indoor study includes:

Forest Botany	Forest Protection
Geology and Soils	Book-keeping and Accounts
Meteorology	Surveying and Mensuration
Silviculture	Forest Utilization
Forest Management	Estate Work.

During the past twenty-five years young men who have gained their certificates have, with very few exceptions, readily found openings for their services and many have earned well-merited promotions. Most of the certificated forest apprentices have chosen the Forestry Commission's Service, some having risen to the rank of District Officer; a small number have secured subordinate appointments in the Colonial Forest Service and have done well, promotion to the rank of Conservator of Forests being not unknown;

but the proportion attracted to private service has not been large, a state of affairs that ought not to be taken as a criterion for the future. Pay and prospects generally have improved of recent years, and posts in Government Forest Services are also pensionable to established forester grades. Grading in the lower ranks under the Forestry Commission varies according to experience and the responsibility involved, and at present includes:

Foremen (non-established) .	85*s.* to 90*s.* per week inclusive (or 80*s.* to 85*s.* with free house).
Foresters Grade II . .	£150—7. 10*s.*—£200 + house or house allowance.
Foresters Grade I . .	£200—10—£250 + house or house allowance.
Head Foresters . .	£250—12—£300 + house or house allowance.

(During the war years the rates of pay to forester grades have been augmented by temporary allowances.)

In private employment the designation varies; foresters may be known as head woodmen or head foresters, while, on a few of the more heavily timbered properties, there are senior positions as woods managers. Pay and emoluments also vary. Up to the present there has been no attempt at standardization, a matter now receiving the sympathetic consideration of the Royal Forestry Societies. But whatsoever the circumstances, and under whatever title the work is carried out, the same qualities of integrity, intelligence, and resourcefulness are indispensable for success.

Life in the forests and woods is a good life—'*crede experto*', as Ingoldsby observed on one occasion, 'trust one who has tried.' There is, however, this important proviso that, to make a satisfying career of it, the peg must be so fashioned as to fit closely to the hole. Forestry offers no comfortable niche to a man whose heart is not in the work, whose ideas are dominated by the 'get rich quick' school of thought, or in whom the joy of creative work, and of making things grow, fails to strike a healthy and responsive chord. To the right man, equipped with the right training, be he forest officer or forester, professional forestry holds out broad scope for the exercise of ability, initiative, and high endeavour in the service of his fellows and posterity, in a field of interest wide enough to satisfy the most active mind and body. And, withal, there is the assurance of a competence, modest though it may be.

FORESTRY AND THE NATION

If it were done when 'tis done, then 'twere well
It were done quickly.

The way is plain as way to parish church. SHAKESPEARE

We have seen in the foregoing chapters that the chief purposes of forestry in Great Britain are to provide a security reserve of the right sorts of timber in forests standing within our shores, to foster silvicultural and wood-converting enterprise, and to fill a gap, hitherto not more than partly filled, in the organization of the country-side. Except for unnatural war-time activities in the home woods, national dependence on the timber importer has been abject, and there is now no valid argument to be brought against the case for planting and replanting. The storage of a national timber reserve in bulk is impracticable for reasons already stated, and no way out of the difficulty suggests itself except to put our woodlands in order and to afforest. It is idle to reflect upon the enormous benefit now to be enjoyed if a National Forest Policy of moderate scope had been pursued throughout the prosperous years of the nineteenth century, or on the praise such foresight would call forth at a time like the present, when the fruits of the investment would be so thankfully grasped! To-day forest building is forced upon us at much greater cost, and it cannot be overlooked that time is a factor in forestry as well as cash. In spite of condemnations evoked by ill-grown samples and intermittent supplies, timbers of all the usual selected grades can be grown in Great Britain, moreover the yield per acre, per annum, is greater and more speedily attained here than in many exporting countries. We have to thank our mild, equable climate for this, and our wide range of soil conditions which suit an unusual number of species of the best timber trees of the temperate world. Investigations into the properties of well-grown, home-produced timbers, carried out over a long period, confirm their excellence; good management gives assurance of quality. Quality, durability, and adaptability depend upon choice of the right species, and on silvicultural treatment by which rates of growth, and the form and dimensions of the tree, can be controlled within all necessary limits.

Events have brought us to this pass: Britain, once a forested

land, can no longer ensure the safety of her island position unless parts of the country on which primeval forests formerly flourished are again brought under crops of trees. On the lands we can afford to deem afforestable no form of cropping equals, in volume and value of production, that obtainable from a forest crop. The reliability of yield and the capacity to give employment are also unequalled. There is no policy of assurance within the bounds of imagination which can pay so much to its holders by way of bonus as that arising out of an enlightened and steadfastly pursued Forest Policy. But let us never forget our past record in this regard: it has invariably taken a great calamity to turn the national mind to national forestry, and never yet in such matters has the will of the nation proved pertinacious enough to continue its declared policy for many decades afterwards.

It cannot be claimed that advances in science and discovery have always been applied in the best interests of the British people. Nothing exemplifies this more clearly than the reactions of industrial power on the utilization of land and on the distribution of the populace. The soil has not been regarded as our greatest possession, which it undoubtedly is. Faith in the land to yield profit has been shaken by negative policies in regard to rural land which will no longer serve; agricultural populations have drifted townwards and, except under the temporary spur of food shortage, there has been little to stimulate rural industry; certainly there has not been much evidence to be seen of forestry as a systematic timber producer. The distribution of population in the United Kingdom is a pointer in itself. In contrast with extremes of congestion in other parts, the numbers of people supported by some of the non-industrial administrative counties, leaving inhabitants concentrated in county boroughs out of consideration, are quite absurd. For instance, the counties of Inverness-shire, Perthshire, and Argyll (not to mention the barren counties of northernmost Scotland), together extend to 6¼ million acres and boast of only one resident to each 23·5 acres; Merioneth and Radnor are inhabited only to the extent of 1 to 11 acres; Cumberland and Westmorland, 1 to 5·5 acres; while the North Riding of Yorkshire holds no more than 1 to 4 acres. The ratio over the country as a whole is 1 to 1·25 acres, and yet, in certain manufacturing centres and large cities, congregations equal the most thickly populated parts of Belgium. Incidentally, Belgium possesses 18·4 per cent. of forested land against our (reputed) 5 per cent. It is

worth noting that the total population of Scotland declined by 39,943 persons between the years 1921 and 1931, the period covered by the last published census returns, and an overwhelming proportion of Scotland is agricultural as opposed to industrial.

The resources of Great Britain's 16 million acres of rough, uncultivated land have never yet been fully employed or even explored to the full. Grazing and afforestation offer the chief productive possibilities, but there are other minor utilizations. None can be considered independently because their values are largely interdependent. What is certain is that these bare lands, if regarded as a whole and dealt with on a broad plan, will support far greater numbers of families than is the case to-day. The requirements are regular employment based on profitable production; employment cannot expand, or even remain static, unless all practicable forms of exploitation are linked into a general scheme with proper regard to the poise of well-balanced economic life; each component enterprise must bear its due weight and no possibility should be ignored or set aside. New life and new occupations are needed in all remote country districts, and most of all on moor and fell; these so-called waste lands which cover a full quarter of the total area of the country and where populations continue to shrink in consequence of isolation and restricted means of livelihood. Readjustment after the upheavals of a great war is not a simple matter, as we found after the Napoleonic wars, and again after 1918. Military and civil demobilization, and the change-over from war production to the arts of peace, raise nation-wide difficulties of remobilization. The demand is for work and a settled life, which it is the expressed intention of the Government to fulfil. Towards this forestry offers something beyond the security of a timber reserve, although it must be said frankly that the volume of employment created by a Forest Policy, or any other *ad hoc* policy, is not without limit.

In the search for raw material on which to found our share of the universal expansion of trade looked for in post-war years, the importance of primary production cannot fail to be borne in upon the consciousness of the nation. Production and maintenance of native skill are fundamentals of capacity to trade, and what is good for favourable trade is good for the people. Jeremiahs foretell poverty as a result of the unbridled extravagance of war, and neglect to produce to the utmost from the soil may well prove the Jeremiahs to be true prophets. On all counts the more we grow for ourselves the better; if Great Britain cannot hope to make herself

independent of foreign-grown timber, she can secure the growth of two-fifths of her normal requirements without actual harm to the volume of staple production in other directions. But until forests and forest industries are everywhere accepted as an integral part of the economic scheme, the pattern of rural development will not be complete. Planning must needs be comprehensive if everyone is to have a useful and congenial job and a living wage when fighting ceases. Many men will ask for permanent employment when the war is over, and there will be a considerable body of young fighting men who will not readily surrender a yearning for life and work in the open air.

There is a further point. Forestry offers more than anything yet thought of as a check to the drain of men and their families from the uplands of Wales, the Highland glens, and the poorer, unprofitable farm lands in other parts. Sheep grazing and other forms of agricultural husbandry on our poorer lands have failed to retain the men required to keep the lands so occupied from progressive deterioration. It is true that rough grazings can be improved, and there is deer forest and grouse-moor capable of conversion to grazing-ground; but the improvement of herbage entails expenditure, and money thus spent fritters away unless the improvements are maintained. To retain efficiency on improved lands additional local labour must be at call, and to ensure that labour will be there when wanted, a broadening of wage-earning possibilities beyond the scope of existing land utilizations is indispensable. Neither the money spent by tourists nor the social and industrial boon of cheap electricity is a solution of the problem; what is lacking to bring men back to the 'out-by' districts is a basis of local wage-earning on which they can rely, and this together with reasonable amenities—enrichments which only become possible where regular employment is to be had. Creative work at regular wages is exactly what properly planned schemes of afforestation are able to promise. Quite apart from concerns of timber supply, forestry is important in any general review of land policy, if only because its aid in the resettlement of population also solves the problem of retaining local labour to help to keep lands devoted to hill farming sweet and in good heart; the attraction of additional families also revives local markets for milk and other produce to the enhancement of farming profits. The competition of imported goods, and lure of the cinema, are not the sole reasons why men and flocks continue to forsake the valleys and hills.

The ratio of employment to acreage afforested rises to its climax only as forests develop, although, from the first, forestry absorbs and retains more labour than any other large-scale industry to which the poorest of our lands are adapted. The volume of wage-producing work does not recede from the peak where principles of good silviculture are observed in forest management. The most informative data regarding forest employment come from Germany,[1] where, on the average, each hundred acres of woodland provides a livelihood for one woodman, and for four men in addition, in industries based on the forest and its products, that is five men in all. Corroborative evidence is beginning to accumulate in this country; striking instances are developing of the wage-capacity of our new forests and there is no reason to regard the German figures as exaggerated. Many new homes are required for housing forest workers when building can be resumed, with possibilities for the formation of new village communities as a help towards the wider distribution of population that is so earnestly to be desired.

Thus, British forestry claims two outstanding political and social virtues: the restoration and conservation of home-timber resources, and the settlement of labour. These things include the creation of new wealth and increased scope for wage-earning. They also contribute towards a more rational use of our land and to the health and pleasures of the people. This last consideration is by no means the least in importance. Like the peoples of a number of other nations, the British people have squandered their forest heritage; the joys of forest possession have been all but forgotten by the nation, and now war has devastated the stands of timber we had left. Primarily, reafforestation must be the task of the State, but, within the general policy, private ownership plays a big part. The State is also concerned with the direction and co-ordination of forestry research, experiment, and education, none of which we can afford to neglect. Forestry in Great Britain has its own special problems and differs in many respects from the forestry of the great continental countries; a British School of Forestry is arising, which will develop as systematic investigation continues into the silvicultural conditions peculiar to our climate and soils.

Woodlands are apt to be taken very much for granted in popular regard, and figure as parts of the landscape rather than objects of amenity which can also be directed to the service of the man in

[1] Heske, *German Forestry*, 1938.

the street in numberless ways, many of them intimately interwoven in the common pattern of existence. It is unfortunate that such definite barriers have grown up between life in town and country, and that the result has been the evolution of separate trains of thought, quite foreign one to the other. Narrow streets breed narrow ideas and self-centred enterprise, and primary products, such as wheat, meat, and timber, are accepted without care as to the manner in which they are produced, or from whence they come. In our time, deprivations of woodland products have brought little but temporary inconvenience and, in war-time, frantic searches for substitutes; our understanding of all we owe to forests, and the things we obtain from them, has grown dim. Nor will the value of forests in Great Britain be clearly visualized until more is known of woods and woodcraft by the people at large. Forest lore and the elements of national forestry ought to be taught in our schools, and followed up in popular publications dealing with life in the country, of which there are all too few. By these means, and by access to woodland, people will become aware that forestry holds concepts important to us all in which all can share.

There are those who doubt if wood will remain the essential commodity it is at the present time and think that, one day, timber may be deposed from its pride of place in the world's scheme of things by the skill of workers in metals or plastics, or by other agencies as yet unknown. But there is nothing just like the wood of trees, with its cellulose, lignin, and other more volatile constituents; as soon as one form of utilization becomes obsolete, ingenuity discovers more. In one form or another wood is likely to defy its competitors for many a long day to come; civilization has not yet arrived within the remotest anticipation of an epoch when mankind may be willing to forgo the aids and comforts afforded by forests and the raw materials they provide.

The replanting and after-management of the sorely devastated privately owned woods is a domestic problem of serious concern in National Forest Policy, but it is not the simple problem that many of its advocates sincerely believe it to be. It must be recognized that there are complexities which beset the practice of forestry on the average private estate, some of which tend to render an orderly sequence of silvicultural operations difficult to carry out. In most cases the points at issue are forced into prominence by economic considerations, the incidence of taxation, and personal inclination. As to taxes, when existing tax law is clearly

understood, it is seen that woodlands, if looked at as a separate item, and not aggregated with the estate as a whole, are gently treated. But other powerful influences are also incidental to the general position. It is important nowadays to bear in mind that land-owning families do not enjoy the same assurance of continuance of ownership as formerly; it is no longer so certain that heir will succeed heir in possession, or that an estate will remain intact from one generation to the next. The traditional security on which country estates developed and prospered has been undermined. Without security of tenure little is left on which to rebuild private forestry except individual enthusiasm for silviculture, which may tend to be either practical or abstract in its application. All this is at variance with the long-term nature of successful forest management. Major financial and technical difficulties will, no doubt, be overcome, but, if the work of rehabilitation is to succeed, there must be no deviation from the main purposes of forest policy.

In the extremities to which we have been exposed, private owners have unselfishly placed their trees and woods at the disposal of the Nation. It has been truly fortunate that so much good timber was to be found within the country in our time, but it is just as well to pause to consider how it came about that this invaluable reserve came into existence. Statesmanship has played but a small part, and, in general, the notion of conserving growing timber for national use has not always been the principal motive of private planting. As wealthy landowners of past generations competed with one another in the building and maintenance of great country houses, so they planted their woods, and loved them for their scenic beauty, for the interest they afforded, and for their sporting value. The standard of woodland management, though high in some domains, has on the average been far from systematic; too frequently there has been reluctance to thin, fell, and replant as occasion has demanded, or, in fact, to do anything which might detract from the amenities of the moment. It is only here and there (and more particularly in Scotland) that estate forestry has been preoccupied, first and foremost, with production and direct profit. But in spite of all that has militated against good forestry as we must now understand it, private forestry of the past has served its full purpose by giving joy and satisfaction to woodland owners and beauty to the landscape for all to enjoy. It has provided sanctuary for wild birds and beasts (*pace* the gamekeeper), and year by

year, albeit in irregular supply, has furnished enough timber to maintain a large body of trained wood-cutters, hauliers, and sawyers. The vast increases of output necessary to help us twice to defeat our enemies have depended on the skill of these men, so that in the end, estate silviculture, good, bad, or indifferent, afforded both the material and the means to ensure victory. Hitherto private forestry may be said to have done far better than it has been done by.

The pertinent question 'Does forestry pay?' is often asked. Other countries in which the production of timber is a national industry find that forestry does indeed pay the rate of interest to be expected of a long-dated investment. Between the two wars British State forestry was conducted on a basis expected to yield between 3% and 3½% per annum—also a reasonable return on the circumstances. This assessment of the monetary position was founded on careful estimates of production and forest revenues from all sources, and on the cost of establishing and managing forests. But a balance struck between money income and expenditure alone ignores all the other very important national benefits arising from the possession of forests.

Forests give security, and for defence we *must* have timber resources growing on British soil. Then there are the additional aesthetic and practical values, the former including the development of forests for purposes of recreation and study and the latter the opening up of new fields of employment absorbing and retaining labour permanently in and about the woods and giving unsurpassed facilities for the settlement of families on the land. These are considerations which are not reducible to terms of net cash income to the nation, nevertheless they contribute generously to national wealth and well-being, so that an assessment of everything that a considered policy of afforestation means in Great Britain leaves hardly room for doubt that the answer to the query, in our case, is also in the affirmative.

This issue is somewhat less plain to private foresters, and profit and loss less easy to assess from the narrower standpoint of the individual estate. The premisses are complex. Where the answer is sought precisely in terms of net cash revenue a true answer can only be drawn from woods that are managed for the production of timber as a first consideration. The difficulty is that the actual heads of account are rarely simple to state in full; there are values to the landowner such as ornament, shelter, and covert, that are all

real but much less tangible than money income, although all of them must be brought to account in addition to the timber and minor products of the woods, before a true balance can be struck. The principles on which the farmer-owned forests in Sweden and the American wood-lot are managed are seldom applicable, and to draw up a full and fair profit-and-loss statement of the enjoyment value of private forestry operations might well puzzle the skill of the most meticulous chartered accountant. Forest Economics, in Britain, has not yet tabled a summing up of the position in all its aspects, and the question remains without a completely satisfactory answer in the books of at least a great majority of the private estate offices. Two considerations dominate the present situation: finance, and the uninterrupted application of principles of good silviculture. In the background there is a third, and this is the repercussion properly conducted reafforestation may have on the generally accepted principles of estate management. To restore home-timber resources, much money must be found, and the expenditure of public funds in private woods is justified to a point which no one can properly determine until the country settles down again in peace.

We have been warned. In the words of an Elder Statesman,[1] 'The stern hand of fate has scourged us to an elevation where we can see the great everlasting things that matter for a nation'. British forestry has a clear duty to the British people in this island fortress, and to the Empire, a duty which only prolonged and concerted effort on the part of all interests can hope to fulfil. Given co-operation, goodwill, and perseverance, forestry will not fail. Let us take to heart the lessons of our previous short-lived bursts of national silvicultural zeal, and see to it that, as a nation, we do not again deny British forestry its rightful place among our rural industries.

[1] The Rt. Hon. David Lloyd George, O.M.; Speech, 19 September 1914.

Chapter 15

DOES TIMBER FAMINE THREATEN?

Sufficient unto the day is the evil thereof. ST. MATTHEW

WHETHER or not the world's forests will continue to produce enough raw material to satisfy the reasonable demands of all nations is a question of universal concern, and one of radical concern in British forest policy. By afforestation we can provide ourselves with an adequate forest reserve for home security purposes, and if the proposals which have been presented to Parliament are consistently carried out, we can ultimately grow up to two-fifths, or thereabouts, of our normal consumption; but no extent of planting, within practical bounds, can hope to meet the full requirements of a future population verging on its present density in Great Britain. Consequently we shall not be able to do without a share in the produce of overseas forests, and it is fitting to survey, briefly, the present trends and implications of world-timber supply as affecting our position in the years to come.

More or less categorical statements that the world supply of wood will fail, with particular emphasis on the supply of conifer timbers, have been made by a number of authorities, some of whom think that failure may be imminent. Other interests are more hopeful, but it is recognized by those in charge of the world's forestry services that resources are growing less and less. In general, the prospect of real scarcity is obvious, and, in part, is reflected in the steady rise in prices charged for converted goods from abroad, and in the increasing area of second-growth forest being cut over and dealt with, much of it poorly stocked and containing only small timber or species of inferior quality. Second-growth exploitation is rife in Canada and the United States, and in Norway and Sweden, where much of the accessible virgin timber of full growth has been used up and trees of quite small dimensions are now being sawn into boards and battens. The same sort of thing is happening elsewhere: exploitation, hitherto wastefully conducted in many countries, is paying greater regard to the small material and pole-wood, which were formerly treated as of no exploitable value. The history of forest exploitation continues, too frequently, to run contrary to common sense; temptation to overcut to meet urgent, world-wide demands for wood was far from generally resisted up to 1939, in spite of trade depressions and the misfortunes patently

20. *Timber Felling: War-time utilization has taken millions of trees from our woods since 1939*

exemplified in lands in which former wealth of natural forest has been dissipated. Norway and Sweden saw the danger signal long ago, and are among the few nations which had put their forestry on an enlightened and sound economic basis. In the opposite direction, one of the first acts of Nazi Germany was to increase the volume of cutting authorized in German forests. Since then the exigencies of war have compelled exploitation in most countries on a scale contrary to all tenets of reasonable forest administration. In Great Britain the sacrifice of our remaining woods has been an unavoidable measure of defence. For many years, in peace and in war, those who know have been agreed that the world has been living beyond its income in regard to timber; little effective heed has been given to the simple code of economics enunciated by Mr. Micawber concerning income and expenditure.

But the past and its often foolish extravagances are both beyond recall, and it is the future which we must consider. Indications are plain that demands for wood, especially the softwoods, will be on an enormous scale after fighting ceases. War devastation, and neglect due to restrictions upon the consumption of wood for other than military purposes, compel vast programmes of rebuilding and replenishment. Rehabilitation is not a problem only in countries directly affected by the ravages of war, because, in nearly every settled part of the globe, new construction, maintenance, and domestic manufactures have been postponed for want of material or labour. For us in Great Britain the immediate future does not hold out much solid comfort. Our small reserves of growing timber have gone to save ships' tonnage and seamen's lives, and, of mature home-grown softwoods, no more than negligible quantities remain. We are hardly in better case for prime qualities of oak and other home-produced hardwoods. Beyond doubt, so far as concerns timber, our reconstruction task will have to depend on supplies obtainable from abroad, and we have to look a long way ahead for any sign of relief at home. In Great Britain reliance on imported timber will certainly continue, though, up to a point, in diminishing degree as our new forests and replantings come to maturity. Nor shall we find ourselves the only people in the market for wood. All except two or three of the European nations will need to import to help them to make good the damage they have suffered, and to re-establish their manufactures. Neutrals too, and countries and continents remote from the first-hand fury of war, will want supplies to enable them

to overtake arrears of construction and of domestic manufactures. We may well inquire how, and from whence, these simultaneous demands are to be satisfied.

Severe competition for all the timber European forests can produce will certainly not be lacking. Neutral Sweden is, perhaps, in the most favourable position to supply; Swedish resources and capacity to export are highly important factors, and, no doubt, Sweden will make every effort consistent with sound policy to satisfy her customers. Switzerland may also have a surplus, and possibly small supplies will be obtainable from Portugal. But very much larger quantities will be required. We may safely assume that conifer forests throughout enemy and enemy-occupied Europe, with the possible exceptions of Germany and Finland, have been seriously overcut, and that beech, and other broad-leaved forest, has suffered. France and the Low Countries are certain to want more timber than they can produce for themselves, and it will be surprising if Norway, Poland, and Czechoslovakia are able to organize production from their forests, sufficient to cover their early post-war requirements; Greece must also be supplied. We cannot estimate what the production from Russia's great forests will be, nor the extent to which their exploitation will serve to provide the material urgently needed to repair the fearful destruction wrought in Russian cities and villages; but, if the national flair for organizing in war, at which we have marvelled, is turned to use as efficiently in peace, this very gallant nation will, at least, be independent of external supply at an early period, and may be able to spare timber to relieve the general situation. Enemy countries will be short of wood. For the Germans and Austrians there appears to be no option but to continue, for the time being, the cut-throat policy of excessive cutting, introduced into the previously well-managed German forests by the Nazis; Italy must import; Hungary and Roumania may be able to secure sufficient supplies from the Transylvanian forests; and Bulgaria will have access to forests in the Balkans. But the Near East will want timber from the Eastern Carpathians and the Balkan Peninsula, as in pre-war days, and these forests are obvious sources of supply for war-stricken Yugoslavia and Greece. Russia, too, may have an eye on timber from Roumania for the reparation of her Black Sea provinces, and it is certain that timber from enemy countries will figure as an important item of war indemnity, despite the fact that experience may not everywhere be held to encourage the idea of payments of

this sort in kind; what we should not forget in this connexion is that the extent of the devastation our woods have suffered is due to the inveterate will of the German people to make war. How Spain will fare it is not easy to see; however, in the scramble likely to ensue in the world's timber markets, all who have money to spend will doubtless obtain a share.

Other great reservoirs of timber lie beyond the oceans. Up to the outbreak of war in 1939, most of the softwoods imported into the United Kingdom came from the Baltic States, Russia, and Canada. The prospect of severe limitations of exportable supplies from European forests, in the period immediately before us, leaves only the forests of North America from which to draw the balance of our requirements. And here again, Great Britain will not be the only customer knocking on the counter. Domestic consumption in Canada and the U.S.A. will be abnormally large during the demobilization period and after; owing to diminished resources, the United States have been importers of timber for many years. Neither New Zealand nor Australia can be regarded as self-supporting, and the same is true of South Africa. China will want timber, having so little of her own, also the Dutch East Indies. The last two countries may, in part, be supplied from India and Burma, both of which will also have large internal demands.

The mighty tracts of rain forest in Central Africa and South America contain utilizable timbers of many descriptions, and must be brought into reckoning as possible future sources of supply. Sooner or later these immense forests must become commercially more important, but, in the meantime, exploitation presents problems of organization, marketing, and transport, so far only partially solved or not solved at all, and, in South America, problems of politics are also apt to arise. In assessing prospective outputs from the tropics, allowance must be made for all these difficulties, and for local consumption. It is a drawback that the properties of so many excellent tropical timbers, hardwoods and soft, are still narrowly recognized in the timber trade. Exploitable softwood forest also exists in parts of Central America.

In all the circumstances it seems inevitable that inroads into the world's forests, particularly those in the northern forest belt, must, for the present, continue to exceed natural increment, but it should be clear, beyond possibility of misunderstanding, that this policy is, in truth, anti-social, because every year in which the nations outrun the constable (in this case, the forest

conservator) detracts not only from visible forest reserves but from potential future yield. It is everyone's concern to limit the range of forest destruction as soon as may be, and to see that a greedy market does not bring about an orgy of overcutting. Temptation will be tremendously strong to go all out for production without thought for the morrow; demand will be insistent, and the profit motive is strong. It is impossible to state too bluntly that to continue to utilize wood at a faster rate than it accumulates in the forest, is a suicidal policy, and that a threat overhangs the dwindling timber resources of the world, and possibilities of supply in future decades, that is deadly serious. The emergency to which war's wastage has brought the Allied Nations and others, will have somehow to be met, but, in regard to wood, it should be met economically, and forest conservation should take the helm without avoidable delay. If not, then the much talked about timber famine in softwoods is well within sight.

The speed at which virgin conifer forest has been cut over is almost unbelievable. This is particularly true of the forests of the North American Continent, and, naturally, it is always the best, and most accessible, of the timber that is the first to go. Timber stands are classified as merchantable and non-merchantable. The latter may contain excellent timber, but be so situated that exploitation offers no profit; alternatively, non-merchantable areas may be understocked, or the kinds of timber inferior. Canada realizes the heavy drain on her timber lands, and facts and figures recently published in the U.S.A. are worth close attention.[1] Out of a total of 630 million acres of forest land in the United States some 168 million acres are unsuitable to the growth of timber trees, or are not available for the purpose; 77 million acres are virtually unproductive owing to destructive felling and forest fires; and all but 100 million of the rest has been cut over so wastefully that effective production is no more than a fraction of what it ought to be. We are also told that 50 per cent. more timber than actually grew was cut, or burned, in 1943, and, in saw timber alone, the drain was almost twice the volume of the annual growth. The surviving timber stands were reduced by 40 per cent. between 1909 and 1938, and a further serious statement is that something like 80 per cent. of the timber cut on privately owned forest land is exploited without conscious regard to future cropping. Many of the individual States were well forested not so

[1] U.S. Office of War Information, 31 May 1944.

many years ago, and the forest resources this great nation possessed were such that no one imagined they could ever be exhausted. To-day, the position is such that, even if the timber lost each year by fire, insects, and disease, were all saved, the rate of cutting would still exceed growth by a substantial margin. No wonder American foresters see the red light!

And what of cost? Prices affect distribution, and when the pinch of scarcity makes itself felt, prices rise. Without looking beyond the softwood position, published returns over the past thirty years clearly show that the annual quota of sawn timber imported into the United Kingdom has been on the up-grade in cost. The cost to us of manufactured wood and wood-pulp has risen still more steeply and in some categories so have the quantities imported; there is the consideration, too, that by importing wood in a manufactured state we have to pay the costs of producing the manufactured article additional to the price of the raw timber, to the detriment of employment and incidental spending power at home. We are never likely to find foreign fir and pine again procurable at £7. 10*s.* per standard and upwards as in pre-war days, and as our only option will be to make good a considerable part of the annual deficiency that faces us from across the Atlantic, some of it from the Pacific coastal regions of Canada—more than 7,000 miles away by rail and ship—transport alone, with the intermediate handlings, will represent no mean item. All the wood we buy abroad must be paid for, and although rising cost is a symptom and a not root cause of scarcity, the size of the bill will have a bearing on sufficiency of supply.

Apart from difficulties of foreign exchange and fluctuations in the value of money, which are about all the man in the street is able to perceive through the mists of high finance, we cannot escape the fact that the bountiful store of timber accumulated in the world's forests in the course of centuries is almost everywhere being consumed at an alarming rate, or that the forests in which future supplies must grow are rapidly vanishing as exploiters push farther and farther afield. Whatever we may think of the science of economics in its higher flights, it is foolish to gainsay its elementary laws. No one can have his cake and also eat it, and if the means of making more cakes are also eaten up the prospect becomes progressively more bleak.

How then can the timber-supply position be summed up, and how does the summing-up affect ourselves? While timber traders

express optimism regarding post-war supply, foresters gently shake their heads. Both have claim to reason within their respective ranges of outlook. Timber will somehow be forthcoming for reconstruction, but the requirements of the moment, predominant though they may appear to be, cannot be allowed to obscure the future position. In a world of diminishing forest resources, it will be rash in the extreme to throw principles of sustained yield to the four winds. If the kinds and quantities of wood needed in the service of humanity are to continue to be available, the broader purview of the forester must soon prevail, and exploitation be brought within the limits of total periodic growth at no very distant date. The most optimistic amongst us cannot claim that the situation is free from peril, but, if the long-term view is taken, and provided the timber-producing countries faithfully persevere with the conservation and extension of their forests, the answer to the famine theorists will unquestionably be 'No'. The provisos are of first importance. If these nations neglect or unduly postpone their duty, and unregulated cutting is permitted to continue, the answer will just as surely be in the affirmative; the growth potential is already seriously reduced, notwithstanding the remarkable powers of regeneration to be observed on cut-over lands where reasonable measures of protection are exercised. What there is good reason to fear, and it amounts to a moral certainty, is that stringency will be felt in the interim between the period immediately ahead and the time when conservation and the hoped-for reafforestations will begin to fructify effectively—say forty to sixty years hence.

The duration of temporary scarcity can be shortened by self-restraint and, for the relief of British consumers, we must not forget the planting carried out in Great Britain since 1919, and the work yet to be done. Conifer saw-logs, yielding timber of merchantable quality, have been grown in favoured places in England in the exceptionally short space of eighteen years—a quite phenomenal achievement. Many thousands of acres of spruce and pine are now beginning to yield utilizable thinnings, and saw-logs will follow. At first these will be a drop in the ocean of our requirements, but the drop will become a steady stream by the time the exuberance of overseas exploiters is perforce checked for want of enough forests to cut. At present forest administrators have every reason for their fears; while consumers clamour for the body of the forest, traders are eager to supply and to take their just profits. Safeguard lies in the wisdom and authority of governments and in the forester's skill.

Nothing will make an early, if temporary, period of timber famine more sure than unbridled licence, and the time within which famine will pinch, and the period it will endure, are related directly to the licence that forested nations allow themselves to indulge. When the war is over, a universal stocktaking of all forest resources, and assessments of incremental growth, are required. Simple arithmetic will then determine the rate of timber consumption the world can afford.

INDEX